THE

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THE

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CHEMISTRY AND ELECTRICITY.

THE isolation of the physical sciences is fast disappearing, and every year adds to our knowledge of their mutual relations. The discoveries of Oersted, Sturgeon, Ampère, and Faraday in the first half of this century has reduced magnetism to the position of a chapter in the treatise on electricity. It is true that we do not know what peculiar electrical condition of the molecule produces the magnetic effect, but no one doubts that when its true nature is known, it will be found to be closely connected with known electrical phenomena. Till recently no one dreamed of the intimate connection of light and electricity; but Maxwell, by his electro-magnetic theory of light, has annexed that science also to the domain of electrics.

Chemistry, alone of the great molecular sciences, remains to any extent out of contact with the science of electricity. The points of contact, however, are already so numerous, as to encourage the belief that all chemical and electrical phenomena, however different, will yet be shown to be manifestations of the same forces. We would recommend, therefore, the study of chemistry to the electrical student, both from the point of view of theory and of industrial application. It is more especially in the subjects of electrolysis and chemical affinity that electricity and chemistry have mutually assisted each other. It is now accepted that electrolytic conduction is invariably accompanied by chemical decomposition, and, indeed, only occurs by means of it. It is fairly well established that the high tension electric discharge through gases, and the ordinary passage of the current through a conductor, are of the same nature. The only difference between the electric discharge in gases, electrolytic conduction, and ordinary conduction in metals is probably one of the degrees of dielectric strength, or the force of chemical affinity. If the chemical affinity of any two substances has been determined by experiment, their electromotive force in the electrolytic cell can be calculated to a very close degree of approximation.

To explain the connection between electromotive force and chemical affinity, it has been supposed that the atoms of matter are endowed with fixed positive and negative charges of electricity, and that chemical affinity is simply the electric attraction of these oppositely-charged atoms. There are many objections to this theory, though it represents fairly well some peculiar molecular condition of the substance yet to be discovered. Schuster has applied the theory of atomic charges with considerable success to explain the electric discharge in gases. He has found that the chemical relation of the gas to the electrodes has a considerable influence on the electromotive force required to produce the discharge, just as in ordinary electrolysis. When we understand better the relations between chemical affinity and electromotive force, it is within the bounds of possibility that the chemist, in his laboratory, may be able to build up from their elements

many of those complicated organic compounds which hitherto have only been produced by the vegetable or the animal organism. Some extremely interesting investigations have recently been made on the connection between electromotive force and the chemical action of light by Minchin and others, which may lead to important developments.

The industrial applications of electricity have been making considerable progress in recent years. More or less successful attempts have been made to extract metals from their ores by the electric current. Hannay has devised a method of obtaining gold and silver from their ores with cyanide of potassium as an electrolyte, and the Hermite process has been in use for some time for the extraction of copper. Hermite has also with some success applied the electric current to the disinfection of sewage. Among other promising applications of electricity in the chemical industry, may be mentioned bleaching, alkali manufacture, preparation of hydrogen and oxygen, tanning, ageing of spirits, and chemical analysis. Again, therefore, we would say that a thorough knowledge of chemistry will be of the utmost value to the electrician.

THE EFFECT OF POLARISATION UPON THIN PARTITIONS.

The *Physical Review* for the present month contains an account by Prof. John Daniel of recent experiments made by him with a view to studying the curious phenomena of polarisation upon thin metal partitions in electrolytic cells. Dr. L. Arons, reasoning from the effects obtained when very small electrodes are used in a sulphuric acid voltameter with strong currents, suggested the use of thin metal partitions across the lines of current flow—expecting that there would be a development of heat at these partitions, resulting in the destruction of the metal. The experiments of Prof. Daniel were undertaken as an investigation of the subject, and in order to determine the effect of thickness and material, using the same current; or, by varying the current strength in these cases, to determine what function the polarisation is of the current, and, again, to find how the polarisation varies with the time during which a given current flows.

It must be admitted that the problems here set down were of great difficulty, as, indeed, are all questions requiring the accurate measurement of electrolytic resistances and minute E.M.F. changes; it is not to be wondered at, therefore, that the results arrived at turn out to be scarcely more than qualitative. The voltameter employed was a glass vessel, 20 cm. long, 12 cm. wide, and 11 cm. deep. A plate glass partition, 3 mm. thick, was fixed across the cell; it had a central aperture 2 cm. in diameter. A smaller glass plate, with an aperture 1·5 cm., was sealed over the opening in the partition, the metal partition being first stuck in position over the opening in the small glass plate. The end electrodes were of platinised platinum 4 × 6 cm., and 0·1 mm. thick. With $Cu\,SO_4$ solutions, copper electrodes were used. Each side of the voltameter was then filled with solution up to the top of the metal partition, which, in the experiments, was generally gold-leaf. The E.M.F. of polarisation at the metal partition was calculated from the values of the current passing (1) with the partition open, (2) *with* the metal partition, (3) with voltameter out of circuit. The auxiliary resistance required to maintain (1) and (2) equal was also noted; it was measured by the method of Kohlrausch, using an induction coil and electro-dynamometer. A telephone would probably have been more convenient.

The results, as far as they go, seem to indicate that the polarisation on a gold-leaf partition in $H_2\,SO_4$ of good conductivity is zero; the "critical" thickness, below which no polarisation occurs at the partition, in good conducting solutions of $H_2\,SO_4$, $Cu\,SO_4$, and Na Cl is, apparently, *greater* than 0·00009 mm. for gold; 0·00015 for Pt.; 0·0005 for Al.; and it is, apparently, *less* than 0·0004 mm. for gold; 0·002 mm. for Pt.; and 0·002 for silver. Between the limits of critical thickness, the polarisation for a given current appears to increase with the thickness; In $Cu\,SO_4$ all the plates, except those below the critical limit, were destroyed by oxidation. A silver plate was destroyed in less than 1 minute. Thick plates of gold were strongly oxidised in $H_2\,SO_4$, especially with strong currents. Thin gold plates were, apparently, only oxidised under the action of strong or long-continued currents. Aluminium was so intensely oxidised by the current that no satisfactory measurements could be made for this metal, though the thin foil was unaffected. With H_2SO_4 as electrolyte, after a thick plate of pure gold had been used as partition, the end plate was found to be gilded. A thick platinum plate, substituted for gold in one of the solutions, was found on removal to be gilded. With the paper are given curves and tabulated results, together with other details, which are rather difficult to give in abstract; they will, however, repay those who are interested if read in full from the original.

A Potentiometer for Alternating Currents.

One of the chief difficulties in the way of the accurate measurement of alternating pressures and currents arises in the calibration of the instruments. Some of the alternating-current instruments, such as those on the electro-dynamometer principle, give the same reading whether a direct or alternating current is used; and electrometers, and some forms of electromagnetic instruments with soft iron cores, are also adapted equally well for direct and alternating current work. This is not the case, however, with a large class of instruments, and the only method at present available for calibrating such instruments is by comparison with another instrument which has been calibrated by means of a direct current. Such a practice allows errors to creep in. No careful electrician would trust to direct current instruments calibrated second hand, and accuracy is just as important in alternating current work. In addition to this, the collection of cells and resistances which are now included under the name "potentiometer" is exceedingly useful wherever it can be set up, as it measures currents and pressures throughout an enormous range with an accuracy which is quite unattainable by means of any other forms of voltmeter or ampèremeter. It is, therefore, of great scientific importance to be able to extend the potentiometer method into alternating current work, so that comparisons can be made directly with a standard cell. In a paper read before the Physical Society, Mr. James Swinburne shows how this method may be employed. For details we must refer our readers to the published paper, but the essential principles are briefly as follows: A direct pressure is balanced against an alternating pressure by means of a differential electrometer with single-fibre suspension, a "null" method being employed. An alternating and a direct current are similarly compared by means of a differential dynamometer with the controlling spring removed.

THE FIRST THREE-PHASE TRANSMISSION PLANT IN THE UNITED STATES.

An excellent example of a successful power transmission plant operated on the three-phase system is that recently installed at Redlands, Cal., by the General Electric Company. It is the first plant in America in which this system is employed, and its completion marks a new era in electrical history.

In few regions is water-power more appreciated, and electrical power transmission more necessary, than in Southern California. For irrigation alone a water right there is better than many gold mines; for in spite of its marvellous subtropical climate, artificial irrigation is a necessity almost everywhere. Without it much of the country would be barren and forbidding. With it, it becomes a fertile spot. Add to this indispensable irrigation the possibility of using the same water for the distribution of power over a region where coal is from $8 to $12 a ton, and the importance of electrical power transmission, is evident enough.

The first water-power in Southern California to be utilised for the distribution of power as well as light is that situated at the mouth of Mill Creek Canon, nine miles from the city of Redlands, one of the most flourishing of the younger cities of the State.

Fig. 1.—View of the Power House.

Less than two years ago a few of the public-spirited citizens of Redlands saw the chance of utilising the fine Mill Creek power, and organised a company, chief among the members of which were Messrs. George N. Crafts, H. H. Sinclair, F. G. Feraud, and George S. Ellis, who have in other ways played an important part in the development of this city.

The enterprise was rapidly pushed forward, and about nine months ago a contract was closed with the General Electric Company for the necessary apparatus.

The hydraulic part of the installation is of more than usual interest. Mill Creek is a fine and unusually reliable stream that springs from the slopes of mountains, San Bernardino and Graback, the two loftiest of the Sierra Madre range.

The main body of the stream, and a convenient in-take, was found near the mouth of the canon, and, by a comparatively small deflecting dam of masonry 40 feet long, and headwards, it was possible to turn the water into a tunnel 160 feet in length, cut through the rock, and thence into a heavy steel pipe line, which was brought down the stream a distance of 7,250 feet, where was obtained a convenient site for a power-house. At the end of the tunnel is a sand box 75 feet long by 25 feet wide to catch any sediment before the water can enter the pipe line. At this point the fall is in nearly 353 feet, giving exactly 160 lbs. pressure to the square inch in the receiver that terminates the pipe line, which can deliver 2,400 cubic feet of water per minute.

The power house, as shown in the illustration, is for the most part an excavation not far from the back of the creek, made in a singularly heavy rubble composed of large water-worn stone very compact and dry. The roof is erected on very low side walls, and under the lean-to on the right, is the wheel pit with a receiver and Pelton wheels. The wheel shafts extend to iron shutters, set in windows in a mass of rubble retaining wall that bounds the wheel pit, into the dynamo room, where they are directly coupled to several machines. This dynamo room contains the following apparatus, as may be seen from fig. 2, which gives an excellent view of its interior:—2 50-kw. 10-pole three-phase generators, delivering current directly to the lines at 2,500 volts between lines; two D-10 exciters, each capable of energising the fields of both generators, and one 50-light 2,000 C.P. Thomson-Houston arc dynamo. With the stream at its lowest, 800 H.P. is developed at the generators. Room is left, and foundations are in place for a third three-phase generator and a second similar arc machine. The large generators, run at 600 revolutions, give 6,000 alternations per minute, and have a rated output of 100 ampères at 2,500 volts. The general arrangement of the station was planned before the contract for the apparatus was let (and, in fact, before the character of the machinery was determined), substantially according to the designs of the late A. W. Decker, whose recent death was a great loss to the electrical interests of of the Pacific Coast.

To each of these large machines just mentioned, a Pelton wheel is directly coupled, the three-phase generators being supplied with 200 H.P. double wheels, each operated by a double nozzle.

The regulation of the hydraulic power is by the ordinary differential nozzle operated by Pelton differential governors, driven from one of the exciter shafts. A second small differential governor, driven from the other exciter shaft, steadies the action of the first by regulating the exciter wheels. The water having done its work, is discharged into a ditch and utilised for irrigation purposes.

On the side of the dynamo room, opposite the dynamos, are located the switchboards. The chief interest of these lies in the three-phase switchboard for the two big generators. This is elaborately devised to meet every condition or combination that it might be desired to make with the two machines, and the two circuits that run from the power house. Either machine can be thrown on either circuit, and both machines in parallel, on either or both circuits. At present the parallel connection is chiefly used in shifting over the load to obtain perfect continuity of service. A 6-ton travelling crane permits ready handling of any of the machinery.

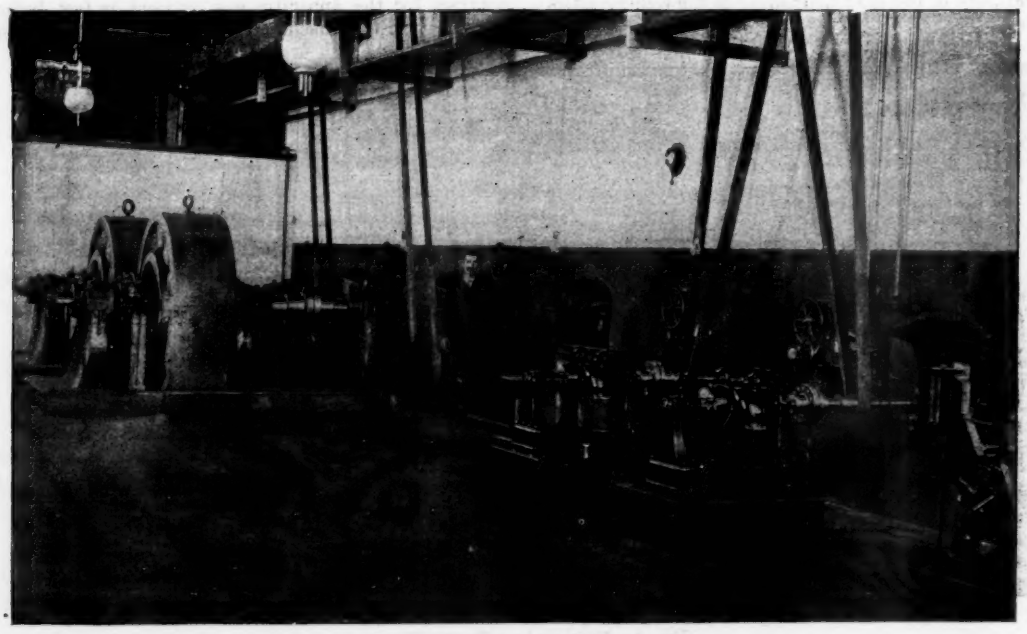
The interior of the station is a model of its kind. Particularly to be noted are the excellent foundations which are carried deep down into the solid rubble, and are built up with a liberal supply of cement, sharp gravel, and small stones. In the upper portion of the foundation equal parts of cement and gravel are used, and the top layer is of pure cement.

To this smooth surface is bolted a framework of oak about 3 inches thick. On this rests the dynamo, which is secured to it by bolts firmly screwed up and bedded in sulphur.

The result of this careful foundation and excellent alignment of shafts is that the large generators run without even a tremor at the bearings.

The whole fitting of the station is admirable, and the same care is extended to the little house of the engineer (seen in the first illustration), which is lighted from one of the exciters, and is to be furnished this winter with electrical heating and cooking apparatus.

From the power house are run two three-phase circuits, each composed of three 00 B. & S. wires. One of these runs to the company's office at Redlands, a distance of 7½ miles, and from thence is distributed over the city for lighting and power purposes. On a substantially built pole line the other extends to Mentone, 4½ miles, where is located the artificial ice plant of the Union Ice Company.



Interior of Station.

In this plant is installed a self-starting tri-phase motor of 150 kw. It runs at 750 revolutions and 6,000 alternations and is synchronous, it is belted through the medium of a counter shaft to two large compressors for the ammonia, a circulating pump for the compressor jackets, a force pump to supply water for the ice, and a small elevator for handling the ice. In order to ascertain the point of synchronism, a Thomson acoustic synchroniser is employed, and gives unqualified success. The ice plant is of the so-called "Pipe" type, and the freezing room and condensers contain nearly 20 miles of ¾-inch iron pipe, in testing which the motor was stopped and started at short intervals for several weeks. The operation of the ice plant is continuous, the load being on the motor 24 hours a day, and, barring accidents, 365 days a year. The motor plant at this point is likely soon to be increased to keep up with an increase in the plant.

From the main Redlands circuit a number of lines are taken off for the ice plant, and also for the neighbouring town of Mentone. There are now in operation 30 arc lamps besides over 1,000 16-C.P. incandescent lamps, distributed over three legs of the circuit. A number of small induction motors without commutators or collecting rings are to be installed shortly, to meet the demand already created by the success of the plant. The transformers are very similar to the ordinary General Electric type T transformer, except that they are designed for 50 cycles per second, and to reduce the pressure from 2,200 to 110 volts. As far as possible rather large transformers are used with comparatively long secondaries. These are used only directly at the point where light and power are delivered.

No trouble whatever has been experienced from any unbalancing of the lighting lines. In fact, shortly after the plant was started up, the largest single block of lighting in the city, wired for three circuits, had these circuits worked for several nights on two legs of the tri-phase generators, pending the setting up of the third transformer; and, although the lights from these two legs were set in adjacent rooms, where both would be seen at once, not the slightest trouble from unbalancing was evident.

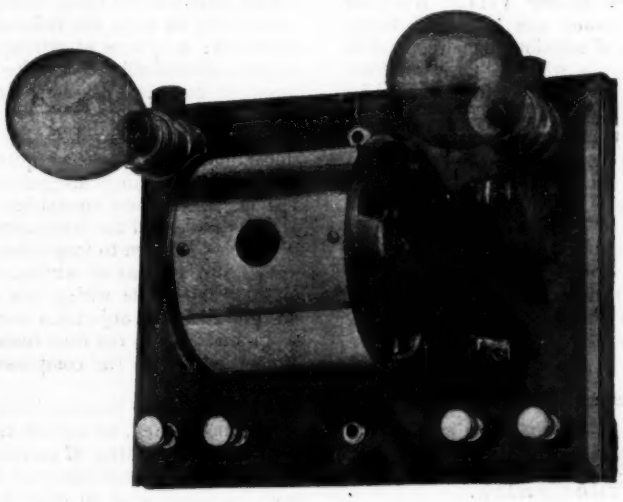
The first generator reached Redlands September 1st, and September 7th incandescent lamps were turned on in Redlands, where arc lamps had been previously working since the latter part of July. September 13th the motor at the ice plant went into commercial operation. The whole plant has been running steadily, and doing good service ever since.

The plant has now been in thoroughly successful operation, and the General Electric system and apparatus has given entire satisfaction for several months, and with the progressive and business-like management of the company, bids fair to be not only a successful power transmission, but an eminently satisfactory investment. Its operation has been singularly free from difficulties of every kind, and it appears to be a thorough demonstration of the adaptability of the General Electric Company's three-phase system to the work of transmission for both power and lighting.

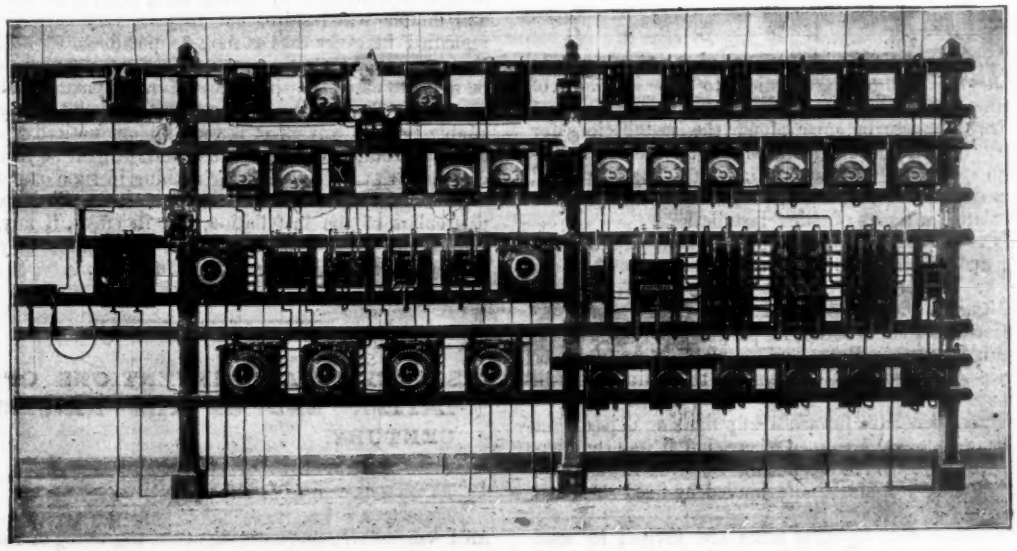
The Acoustic Synchroniser.

With the great use of alternating current machines, and with our modern ideas of central station practice, it is frequently desirable to run alternators—single-phase and poly-phase machines in parallel. Athough alternators have not hitherto been run in parallel as a general thing on this side, the practice is not infrequent in Europe, where it has been made the subject of much study. The operation of alternators in parallel is, however, receiving more attention here, and a device to indicate in the most delicate, yet effective manner, the exact point of synchronism in speed and coincidence of phase of two alternators has become a necessity. The requirement is met by the acoustic synchroniser, which the General Electric Company has recently brought out, and which is fitted in this station. It consists merely of a cylindrical iron case, with an aperture in the side,

each end being closed by flexible diaphragms, each of which has, opposite its centre, the pole of an electro-magnet. In using this device, one of the magnets is connected in circuit through a transformer with each of the machines to be run in synchronism. The current is then turned into the magnet coils, and the diaphragms emit a loud clear note. As the machines approach synchronism, the notes from the diaphragms approach closer in period, and begin that loud, periodic sound, known in music as beats.



Synchroniser.



Switchboard for Electric Plant at Redlands, California.

As the two machines more nearly approach synchronous speed, the beats grow slower and slower, until finally the diaphragms fall into unison, and each gives out the same low, clear note. At this moment, which is sharply marked, the switch connecting the two machines should be thrown in. So sensitive and distinct is the indication of approach of synchronism, that it is possible to throw two machines together with hardly a quiver upon the ammeter in actual circuit.

The immense superiority of this acoustic apparatus over the old phase lamp device cannot be disputed. It is much more sensitive, indicating distinctly the small differences from synchronism, which the phase lamp fails to detect.

The synchroniser was shown by the General Electric Company in its Power and Mining Department at the Chicago Exposition, where it attracted considerable attention, especially from foreign electricians. When it was shown to Prof. Von Helmholtz, and its operation explained, he expressed himself delighted. It was a development in his own field of acoustics, and showed how electricity and acoustics could work together for scientific benefit.

Our illustrations show the switchboard fitted up, with its different regulating and controlling apparatus. The synchroniser, which the irreverent Calfornians have labelled the "growler," is shown in the upper left-hand portion of the board. Its operation is perfect, and it has not been known to fail in its functions even once.

AIR-CORE TRANSFORMERS.

By FREDERICK BEDELL and ALBERT C. CREHORE.

In a paper on "The Behaviour of an Air-Core Transformer when the Frequency is below a certain Critical Value," read before the Physical Society, October 27th, 1893, Mr. E. C. Rimington has called attention to the case in which the primary current of a transformer falls off when the secondary is closed. This phenomenon was noted by us last spring, and attention called to it in the *Electrical World*, June 17th, 1893, in article 5, on the "Theory of the Transformer," where a curve is drawn (fig. 14) showing the value of the primary current for different loads. We have not yet seen the full text of Mr. Rimington's paper, but from various references to it would infer that much of the same ground has been covered by him as was given by us in a paper

read before the Electrical Congress in Chicago last August, entitled "General Discussion of the Current Flow in two Mutually Related Circuits Contained Capacity," printed in full in the *Physical Review* for September-October, 1893. In a more recent communication, Mr. Rimington calls attention to the fact that Mr. Kennelly, in an article entitled "The Impedance of Mutually Inductive Circuits," in the *Electrical World* for October 21st, covered some of the same ground as given by him in his paper before the Physical Society above referred to. In a geometrical treatment of the same subject, "Theory of the Transformer VIII.," *Electrical World*, November 25th, we showed the identity between analytical and graphic methods of solution, including that of Mr. Kennelly, and showed that the whole is derivable from the results given in the paper above referred to, presented by us before the Electrical Congress.

This decrease in the primary current of the transformer as the load increases, where the constants of the transformer have certain particular values, is certainly an interesting one although the amount of increase would always be small. Although the transformer has been the subject of a great deal of discussion, and its theory has been approached from all sides, and the instrument experimented upon by many different methods, it is still a fruitful source of study to the theorist and experimenter, and there is still room for the discovery of many facts interesting and unique.

RULES AND REGULATIONS FOR ELECTRIC LIGHTING STEAMSHIPS.

By RANKIN KENNEDY.

I.

The rules and regulations which we are about to suggest in these articles are put forward as guides to those in charge of installations on board ship, and also more particularly for those who require to choose or superintend the installations for steamships. The author has in one way or another been connected with steamship electric lighting for many years, and has inspected over 100 installations and drawn up specifications and plans for scores of ships' installations.

In many cases plans are drawn up by shipbuilders or their engineers, upon these contractors must estimate and tender for the work. In such cases, the contractor is freed from much responsibility, but the installation is usually faulty and contains apparatus not the best for its purpose, and often costs more than it is worth. Rules and regulations would be of great service in such cases as guides on the main points in drawing a specification.

Some shipbuilders have formed a ship lighting department of their own, employing a trained electrician at its head controlling a staff of competent workmen. But even in that case the owner's interests would be safeguarded by fixed rules and regulations.

In some cases ship lighting firms are invited to send in plans, with prices, for the whole installation on a ship in progress; this throws all the responsibility on the contractor, but it gives splendid opportunities for cutting prices. The cheapest estimate usually secures the contract. Rules and regulations in such a case would bring about uniformity in the principal details of the plant tendered, and leave no room for scamping important parts of the work.

In some cases a new scheme for wiring, or for some other part of an installation, is submitted by a contractor or tenderer. Rules and regulations should not be of such a nature as to preclude the adoption of improvements; they have for their object the reliability, durability, and safety from fire of the installation, preventing the use of materials and appliances known to be unreliable or dangerous in the circumstances under which they are placed in ships.

It is not presumed that the rules put forward in these articles are to be accepted as anything more than suggestions open to discussion and upon which more perfect regulations may be based. If rules are to be drawn up, the work should not be left entirely to some officials or office outside of the electrical business, they ought to be thoroughly well threshed out by electrical engineers, so that no unreasonable restrictions may be allowed to creep into them.

We shall divide up our rules into classes for each circuit on a ship. In every ship the lights are divided into circuits indicated on the main switchboard, usually: 1. Engine room. 2. Boilers and stoke-hole. 3. Holds. 4. Deck lights, including side lights, masthead and anchor lights. 5. Cabins, saloons, officers' quarters. 6. Seamen's quarters, galley, cattle decks, stores, and portable lamps. For each of these we divide out the materials into: wires and their protection, switches and fuses, fittings.

In nearly all ships the different circuits require different treatment; a system of wiring and fittings suitable for a saloon is not suitable for a stoke-hole, yet in some ships the wires are no better protected in the stoke-hole than in the saloon.

The main switchboard, engine and dynamo, and the lamps, globes, and fancy brackets require little attention in drawing up rules; these things are generally pretty well looked after. The engineers know something about the engine and dynamo as a rule, and the lamps, brackets, and switchboards are all visible and open to inspection.

The two systems of wiring, single and double, must be considered. Single wiring has advantages, and is common enough. Although objections have been made to it on theoretical grounds, it has not been found to have any in practice; it does not affect the compasses any more than the double wiring does.

The author has been on board many steamers while they were being swung, to correct the compasses, and has tested the effect of switching off and on one and all of the circuits, without detecting the slightest deflections. Some dynamos have been so placed on ships as to affect the compass while working, but that effect had nothing to do with the wiring.

It is possible, and cases have occurred, where compasses have been influenced by electric light circuits on both single and double wired ships, but they are very rare and easily remedied in every case as soon as possible after an installation is finished. The compasses fixed, a series of tests should be made to ascertain the effects of the dynamo and of the circuits on the compass. These tests are not always made, simply because any effect is very seldom noticed when they are made, but, nevertheless, such tests should be insisted on, especially as they cost little or nothing in time or money.

A schedule is sometimes required to be filled up, giving particulars of the installation, and its effect, if any, on the compasses. It is issued by Lloyds—but whose duty it is to see it correctly filled up is a doubtful point.

DISCOVERIES AND INVENTIONS OF THE LATTER END OF THE NINETEENTH CENTURY.

By MOONSHINE.

As I was walking one morning at the beginning of November last in the neighbourhood of Chancery Lane, a signboard, bearing the following inscription, attracted my notice:—"Mr. Cursitall Street, Patent Attorney. Advice gratis to all Inventors. No idea too simple or too complex to patent. Speciality—perpetual motion and old ideas." My curiosity was aroused by this legend, and I entered and enquired for Mr. Street. I was shown into a comfortably furnished room, and in a few moments Mr. Street walked in. What was my astonishment in recognising an old acquaintance whom I used to work alongside in the physical laboratory of —— College some years previously. The recognition was mutual "Hullo, Jones, how good of you to look me up. How did you find me out?" "I was attracted by your door-plate," I replied; "but even then I had no idea that I should find you here; you see I never knew your—er—your first name, and I never heard of you after you left the college; but you appear to have a considerable establishment here; you must be doing well."

"Splendidly," replied Street, "for the last year, though I had a long discouraging time of it for several years after leaving the college. You know I set up as a patent agent,

hoping that my excellent scientific training would be of use to me. However, I was too conscientious in my methods, for, though a considerable number of inventors, mostly fools, came to me, I set them all by the ears, either because I explained to them that their inventions were absurd and ridiculous, and against all laws of nature, or because I searched the records of the Patent Office so thoroughly, that, in nearly every case, I found that the invention had been patented before. The result was that I made almost nothing out of it, and so a year ago I determined to change my policy. I now encourage all inventors who come to me, and always obtain patents for them, however many times the invention may have been patented before, and however extravagant and impossible the idea. The result is that they all go away thoroughly satisfied, and I am fast becoming rich."

At this moment a clerk announced that a gentleman was waiting to see Mr. Street with reference to a patent for an electric lamp. "Just as I expected," replied Street, "the Edison lamp patent expires next week, and I shall probably have a number of inventors here to-day, all hoping to start another lamp monopoly for themselves. I think you might be interested in hearing some of the notions of these inventors, so if you like to take a seat behind that screen you are welcome to do so, only, whatever you do, don't betray your presence."

I accepted the offer, and the inventor was ushered in.

"Good morning, sir. You wish to consult me about obtaining a patent for an electric lamp? May I enquire what is its chief feature?"

"My idea, Mr. Street, of course is quite new, and it is to use platinum in my lamp in some way or other, although I do not wish to confine myself to platinum or anything definite."

"I understand," replied Street; "just take a seat for a moment while I draft a provisional specification. Here it is; I will just read you a little bit of it, which contains the essence of the invention:—'The improvement consists (1) in the application of platinum in any form, or any other suitable material or combination of materials, gaseous, liquid, or solid, so as to admit of the passage of continuous currents at the same time that light is evolved.' This, you will see, covers everything that can ever be invented, as no lamp can be made except with a suitable material. You will no doubt make a large fortune out of this. Ten guineas, if you please. Thank you. The application shall be sent in at once. Good morning."

The moment after this inventor was out of the room another was ushered in, and I remained behind the screen all day while a constant stream of inventors came and went. In order to be as brief as possible, I will give only just the substance of the inventions which followed, without narrating much of the conversation which occurred. It seemed to me, however, that in many cases Street supplied the greater part of the invention himself. Some of the visitors, in fact, didn't seem to know what they had come for, but they all went away with a valuable invention, and Street got his cash every time.

The next inventor said that he was a large shareholder in gas companies, and was afraid that electricity was going to ruin the gas interests; he had therefore devised a method of combining both sources of illumination. He made an arc lamp in which the globe is supplied with a stream of coal gas at the bottom, which could be lighted on leaving the globe at the top, thereby burning lots of gas with the advantage of the electric light thrown in. Mr. S. added that if the inventor happened to own New River shares, he would add a clause in the specification to the effect that water or steam may be used in place of gas; or, if he was interested in oil, oil might be fed to the carbons. Another excellent suggestion was a combined arc lamp and Bunsen burner. The next inventor gave very much the same tale about his gas shares, only his remedy was of the incandescent order. He heated a platinum wire in a gas flame, by a current of electricity, thereby combining the advantages of the electric light with the vapours of the gas flame.

Then came a man with a very sad voice. He said that he wept like anything to see such quantities of "force" going to waste all around him. He proposed to store this waste force by means of compressed air. "For example, the waste heat and steam of a factory engine or chimney, the waste heat, steam, or momentum of a steamship or locomotive engine, can thus be utilised through air compressors and an air reservoir. The rush of water through canal locks, through water supply pipes to cities, river flow, tide flow, wind power, can be caused to steadily day and night store up compressed atmospheric air, and such motors can assist the steam or gas required for distribution." He then described how this compressed air was to be used for producing electric light in houses. The compressed air would drive a combined "Barker's mill" and dynamo. "This simple apparatus can be let under the floor, or over the ceiling, or fixed in a cellar, or changed in position and details *ad libitum*, without departing from the principle illustrated." The compressed air, having done its duty in rotating the machine, is utilised in a Fletcher's blow pipe to act upon a piece of lime. "In this manner the electric light may be compared to the sun, and the reflectors to clouds ancillary, which furnish a softened light to the shadows." He then proceeded to describe a "practical method" of utilising the waste heat of an argand or other gas lamp for producing electric light. A copper boiler is suspended over the gas lamp, and steam of high tension is generated therein, and drives the dynamo. Another of his methods he described as follows: "A turnstile at theatres and such like places, if put in connection with a compressing pump, will enable one to store up compressed air." The rush of crowds up and down stairs might do the same, while for use in balloons, "air for producing electric light is previously compressed in sufficiently strong receptacles, which air will produce dynamo-electric light in the manner described."

The next inventor was evidently suffering from a similar complaint. His invention was for the benefit of the cyclist. The cycle, or velocipede, was provided with an incandescent lamp and a dynamo, which was driven from the wheels, so that the rider might enjoy a good light, and not have the trouble inseparable from the usual oil lamp. Mr. Street threw out the sugge-tion that the arrangement might form an excellent brake for going down hill, but the inventor would have none of it.

Then came a man who had designed a glow lamp, in which the carbon should be easily renewable. The carbon consisted of a straight stick which hung loosely in wire loops, so as to be at about the centre of the globe. At the side of the globe a tubular extension contained a dozen or so reserve carbons. On the first carbon being burnt out a second one is shaken out of the side tube into the wire loops. Mr. Street thought this could be easily accomplished by any domestic servant; at any rate, it would present no more difficulty than the pigs-in-clover puzzle, or catching a cup-and-ball on the spike.

The next comer, curiously enough, said that he had devised an electric lamp puzzle. The filaments were to be made of such shapes that look at them how you would, or as long as you would, you would be unable to distinguish what the shape really was. There was, however, nothing to be offered by way of a prize to anyone who might discover the shape.

Then came two men who had been working out the vacuum question. The first had a remarkably simple idea for obtaining the vacuum. His lamp was provided at the base of the neck with an extra bulb. When the current was turned on, the air in the lamp bulb containing the filament would expand and run into the second bulb, where it would quietly remain until the current was cut off again. The second man had abolished the vacuum altogether, and filled his bulb with water.

The next applicant proposed to acquire somewhat extensive rights, which amounted to the use of any system using lamps of different candle-power. The claim ran as follows:—"In a system of electric lighting in which a constant and uniform pressure of current is maintained, the combination of lamps varying in radiating surface, substantially as set forth."

The next comer had even wider claims, but I could not catch the precise drift of them; they numbered twenty-two, and to all intents and purposes claimed the earth (not the "earth return," as he seemed to be aware that this had already been appropriated).

"Next," called Mr. Street, just as though he was an American barber giving the signal for the next customer to step up and be shaved. The "next" promptly stepped in, and curiously enough he proposed to deprive a section of the

human race of their chief adornment, to wit, their hair, which he would ruthlessly cut off and make into filaments.

The next man wanted to patent a filament of silk, but found it difficult to decide on a suitable treatment. He thought it should be rendered sticky by some means or other. Finally, after several suggestions by Street, it was determined that the silk should be rubbed with dates, and then dusted with plumbago, after which it might be carbonised directly by electric current.

Then came a shoemaker, who wished to combine electric lamp making with his present business. He proposed to make flat filaments and punch holes in the ends, in which he would insert metal eyelets such as are used in lace boots.

The next man spoke in a very low voice, and was evidently afraid of being overheard. He explained that the feature of his lamp was that it was made in precisely the reverse way to the usual one. The provisional specification was quickly drawn up, and I overheard the following: "Having exhausted the air from the globe, we place inside it one or more carbonaceous fibres."

The next man was undecided as to whether he would use a vacuum or not. Mr. Street explained to him that, as the law distinctly stated that the complete specification should differ as far as possible from the provisional, he could get over the difficulty by saying in the provisional that the lamp contains an atmosphere of hydrogen or nitrogen, and in the complete specification he would say that the vacuum should be as perfect as possible.

The next comer declared that Edison was quite wrong in saying that a lamp should have a high resistance. In order to effect a large economy in the consumption of electricity, he explained that he made a conductor which would offer a much less resistance than ordinary conductors. He therefore coated a carbon filament with platinum, or else coated a platinum wire with carbon. In case, however, that Edison should be right after all, he would increase the resistance of the lamp by inserting german silver spiral resistances between the filament and the leading-in wires.

After this the clerk brought in an important looking sealed packet, which had just been delivered by post. It turned out to be a communication from abroad by a gentleman whilst on his voyage to Timbuctoo. It was headed "Mid-ocean," and claimed the manufacture of carbons for incandescent electric lamps, consisting in treating the fibres of what is known as spring-heeled-Jack, substantially as described. Substantially as described was the following:—"The system or method of treatment and carbonisation to which they are subjected may be any of those now generally adopted."

Next came in a long thin man with a very high collar and small head. His provisional began thus:—"My improved lamp may be described as all neck and no bulb."

The next inventor had a method of perpetually keeping his filament in good condition. A hydro-carbon gas is constantly supplied to the filament. If, however, it should become too much thickened in consequence, air is admitted to burn it down again.

Then came a party who took a provisional for a combined lamp-holder and a May-pole. After him another man claimed the combination of a lamp with a man or beast.

Next a very cheap form of arc lamp was described. It was, however, essential that this lamp should be provided with electrodes of diamonds powdered and moulded under pressure. Then came a self-regulating glow lamp. The length of the hot part of the filament was varied by movable contacts worked by a motor within the bulb.

Next came a man who stated that he had applied to the Patent Office for a patent for an electric lamp which was to imitate a candle, but his patent was not allowed. Mr. Street waxed indignant over such monstrous behaviour on the part of the officials in refusing the application, and advised him to send it in again at once under a different name, and it would be certainly accepted.

Then came a man who wished to popularise the electric light among old-fashioned people in the country, who could not retire to bed unless they had a candle-stick to carry up with them. His patent was simply for a lamp-holder to fit in a candle-stick.

The next man I could not follow at all. All I heard for half an hour were the words, "the invention relates" repeated over and over again.

The next man said that he had been formerly a lighthouse keeper on the Rudyard Kipling Sands, and though he had many inventions in his head, he only wished to patent one just then. It related to the bulb of incandescent lamps which should be made of streaky coloured glass.

The next party came straight from the Royal Institution, where he had just heard a lecture on Magdeburg Hemispheres. His lamp was constructed in two halves, which would be held together by atmospheric pressure. Following him came a man with a large chemical dictionary under his arm. He made his filaments out of the longest names contained in the volume.

Then came several men, one after the other, each patenting a reflector between the legs of the filament.

After them came a man, accompanied by several ladies, who, he said, were his nieces. He informed Mr. Street that he had just broken the bank at Monte Carlo, and wished to celebrate the event. This he proposed to do by a kind of catherine wheel of lamps, revolving on arms of different lengths.

Next came a man who had devised a method of cheapening glow lamps, by abolishing the expensive platinum wire, and using instead glass tubes with silver, platinum and gold coatings.

Then came a lady from the States, with precisely the same invention.

Next came a long procession of people, each with a lamp having more than one filament in the same bulb. After these came a professional burglar. His invention was a walking stick, weighted with lead, in the form of a battery, while a lamp was concealed at the end of the stick. Then came a man who said that he had invented one of those simple little contrivances, so simple in fact, that no one had ever thought of it before. It was for protecting a glow lamp by enclosing it in a wire guard.

At this moment I heard a newsboy outside calling "Terrible colliery explosion." Almost immediately afterwards came the sound of people rushing towards the office door. "Close the outer door," shouted Street. The door was immediately shut, but not before several more inventors had got inside, and they insisted on being attended to, in spite of the lateness of the hour. The first of them narrated how Davy immortalised his name by surrounding the flame of the miner's lamp with wire gauze, and he then proposed to do the same by surrounding the glow lamp filament with similar wire gauze. The next explained that the danger of the miner's electric lamp was lest the circuit should get broken. He therefore enclosed the lamp in a cylinder, in which was maintained a circulation of water. If the lamp globe were then to break, the current would be maintained through the water. Then came in a man whose diaphragm was intermittently making and breaking contact. He enclosed his lamp in a vessel containing soda water. The next man made a portable lamp with a horseshoe magnet inside it, though it did not appear what his object was. The next lamp, also a safety one, was connected to the circuit by means of acidulated water or iron filings. Still another portable safety lamp and battery was described. It was arranged so that, in case it should be moved from the perpendicular, or upset, it would automatically short-circuit itself.

The last to enter was a young man who brought a large certificate under his arm to the effect that he had attained proficiency in the principles and practice of electrical engineering. His invention was for the combination of an exhausted human being, asleep, with naked leading-in wires, enclosed in a receiver made entirely of sheets and blankets, together with an electric shock duly switched on by an alarm clock.

Patient reader, think not that I have been trying to impose upon your intelligence. I have not even been dreaming. If you don't believe it, go to the Patent Office and see for yourself.

One of the Results of the Gale.—On Sunday night the high winds did great damage to the works of the British Insulated Wire Company, at Prescot. A large area of the roofs were stripped, doing damage to the extent of £300. The workmen were sent away until the *débris* was cleared and the roof and machinery repaired.

DISTURBANCES IN DYNAMOS.*

By J. A. MONTPELLIER.

(*Continued from page* 150.)

III.—Abnormal Heat is Produced in the Working Parts of the Dynamo.

34. The abnormal heating of certain parts of the dynamo may depend on several causes, which we will now enumerate. In any case, it is a fault that can soon be detected, and we have only to place our hand on the various parts of the dynamo in order to find out whether their temperature is abnormal. When the heat is not too great to be borne by the hand, there is no danger in this heating, but if the contrary is the case, we must at once proceed to find out the cause of it. If any smoke or smell of burning is noticed, it shows that there is some serious defect, and the machine must immediately be stopped.

Whenever an abnormal elevation of temperature occurs in a dynamo while it is working, we must localise the fault and see in what part it arises. It is evident that the part which is heated most is the defective part; but it is rather difficult to find out which this is while the machine is at work, for the other parts become heated by conduction. The most rational and the surest way to find it is to stop the dynamo and wait until it is quite cold. It is then started again and after a few minutes' working it is stopped and the various parts felt with the hand. It is then easy to find the one which is heated most, for the heat has not had time to extend beyond the defective part. Generally speaking, when a dynamo is working normally, none of its parts should have a temperature above 40 degrees Centigrade higher than that of the surrounding atmosphere. To estimate the temperature, we must, as soon as the dynamo has been stopped, place against the various parts a thermometer which has been protected against radiation by being covered with rag or cloth; under these conditions the thermometer will show the temperature of the various parts of the dynamo before they have had time to cool to any appreciable extent. The temperature of the surrounding air being known, we can deduce from it the elevation of temperature produced by the working of the dynamo.

This first test having enabled us to localise the defect in one of the working parts of the dynamo—armature, magnets, or bearings—it is possible to classify the various causes of disturbance as indicated in the following table:—

A. Heating of the armature.—(*a*) Current too great in the armature; (*b*) Short-circuit in the winding of the armature; (*c*) Foucault currents in the core of the armature; (*d*) Dampness of the bobbins of the armature.

B. Heating of the magnets.—(*a*) Exciting current too great; (*b*) Dampness of the coils; (*c*) Foucault currents in the pole-pieces.

C. Heating of the bearings.—(*a*) Defective lubrication; (*b*) Dust and foreign bodies in the bushes; (*c*) Axle twisted out of line, or not turned true; (*d*) Bushes out of line or too tight; (*e*) The centre of the pulley or the collar of the axle pressing against the bushes; (*f*) Belt too tight; (*g*) The armature too near one of the pole-pieces.

35. A.—*Heating of the Armature.*—The abnormal heating of the armature having been found out either by the hand or by means of the thermometer, the following tests are made in order to ascertain the cause of it.

36. (*a*).—*Current too strong in the Armature.*—When the disturbance is owing to the dynamo being over-loaded, large sparks are also produced at the brushes. This case has been discussed in sections 23, 24, 25, and 26.

37. (*b*).—*Short-circuit in the Winding of the Armature.*—This defect is also shown by the production of sparks at the brushes. We must proceed to find the fault and repair it according to the directions given in section 31.

38. (*c*.)—*Foucault Currents in the Core of the Armature.*—This is a fault in construction which is noticed as soon as the dynamo is started for the first time; moreover, the dynamo demands from the engine, which works it, much more than the normal effort, even when there is no load, and no sparks are produced at the brushes, which enables this fault to be distinguished from the above. A machine established under such bad conditions should be returned to the maker. This defect is, therefore, merely mentioned here, as it cannot occur in a dynamo that has already worked well.

39. (*d*).—*Dampness of the Bobbins of the Armature.*—When the armature bobbins are damp, the resulting elevation of temperature produces watery vapour. We may consider this fault as being like a short-circuit in the armature (section 37), the effect produced being the same.

To repair this defect the armature must be taken away to a place heated to a moderate temperature, or else a current must be sent through it, the intensity of which does not exceed that furnished normally by the dynamo. Under the action of the current the coils become heated and the dampness gradually disappears.

40. B.—*Heating of the Magnets.*—The abnormal heating of the magnets may be due to one of the three following causes:—

41. (*a*).—*Exciting Current too strong.*—This defect is only characterised by the excessive heating of one or more of the magnet coils. When all the bobbins are heated equally the defect is owing to the exciting current being too strong, and, in this case, we have only to increase the resistance by means of the rheostat of excitation.

If, on the contrary, the temperature is raised to an excessive degree in one bobbin only, we must conclude that the defect is due to a short-circuit in this bobbin, except when the dynamo is series wound.* We then proceed as described in section 10. In a dynamo started for the first time, the fault may be due to an appreciable difference in the resistance of the magnet coils. In this case, the resistance of the various bobbins must be measured in order to make sure that the disturbance is due to this cause, so that we do not keep a defective machine.

42. (*b*).—*Dampness of the Inductive Coils.*—As dampness has the effect of diminishing the insulation, the resistance of the inducing circuit is weaker than the normal resistance. Moreover, we find that steam is given off, and that the bobbins are damp to the touch. When the dynamo is shunt wound, we can see, by means of an ampèremeter, that the exciting current is greater than usual.

We must, in this case, dry the magnet coils, proceeding as indicated for the armature (section 39).

43. (*c*).—*Foucault Currents in the Pole-pieces.*—This fault may be due either to a defect in construction, or to variations in the exciting current. We must, therefore, when a new dynamo is put on service ascertain to which of these two causes the disturbance must be attributed. For this purpose, all we have to do is to introduce an ampèremeter into the inductive circuit and observe the needle. The variations of current can only proceed from defective contacts which allow part of the current to pass, for if they were absolutely bad, the dynamo would give no current, and we should be in the position discussed in section 5.

44. C.—*Heating of the Bearings.*—When the bearings are abnormally heated, we can, in certain cases, when it is absolutely necessary that the dynamo should go on working, cool them with water or ice; but this is an expedient which must only be resorted to in exceptional cases, for it is much better to stop the dynamo and proceed to search for the fault which is generally due to the following causes.

45. (*a*).—*Defective Lubrication.*—Examine carefully the oil-cups, see whether they are empty, and, if so, whether there is any escape, which is often the case when they are emptied rapidly, and yet the lubrication of the axle and bushes is defective. Make sure also that the apertures through which the oil passes are not stopped up.

46. (*b*).—*Dust and Foreign Bodies in the Bushes.*—To find out whether the heating is attributable to this cause, we must unbolt the bearings and carefully examine the axle and also the interior of the bushes to see if there is any dust or foreign substances upon them. If so, the axle must be removed, and both it and the bushes must be carefully cleaned.

47. (*c*.)—*The Axle Twisted, Out of Line, or not Turned True.*—A twisted axle can easily be detected, for it turns

* *L'Electricien.*

* When the dynamo is series wound, the defective magnet is less heated than the one in good condition. When the exciting current is too strong in a series-wound dynamo, it must be reduced, either by shunting part of it, or by any other means, for instance, by removing one or more layers of the winding.

irregularly and with difficulty; this defect is seen much better by turning the armature by hand when this is possible.

If an axle is twisted it must be replaced by another. The examination of that part of the axle which rests upon the bearings, will enable us to see whether it is out of line or not turned true. This defect can generally be easily remedied by putting the axle on the lathe, or by filing it if the inequalities are not very marked.

48. (*d*).—*Bushes out of Line or too Tight.*—The axle turns with difficulty, but ceases to do so when the bolts are removed which keep the bushes in place. We have merely to loosen them if they are too tight, or to shift them slightly, either laterally or vertically, if they are out of line.

49. (*e*).—*The Centre of the Pulley or the Collar of the Axle rubbing against the Bearings.*—See whether there is sufficient play between the rim of the pulley or the collar of the axle, and the corresponding bushes. If there is not sufficient play, the pulley must be shifted or the bushes filed. As to the end of the axle, sufficient play can be given either by giving the axle a turn on the lathe to reduce the size of the collar or by filing the bushes.

50. (*f*).—*Belt too Tight.*—This fault may arise from an overload of the dynamo (see sections 23, 24, 25, and 26), and, if so, all we have to do is to reduce it. If it proceeds from too great tension on the belt, which can be ascertained when the dynamo is running free, we have only to loosen it. In both these cases the bearing on the side of the pulley is heated more than the other.

51 (*g*).—*The Armature too near one of the Pole-pieces.*—This fault is due to a defect in construction, which can easily be detected when the dynamo is started for the first time. If the armature is out of the centre, it is attracted more powerfully by one of the pole-pieces than the other. We could, if absolutely necessary, bring the armature into the centre by shifting the bearings. but this is a difficult operation, which might lead to accidents. It is better to reject a dynamo with this defect.

(To be concluded.)

ELECTRIC LIGHTING WITHOUT COST OF FUEL.

We recently, in company with a considerable number of press representatives and others from London, visited some works in Halifax, where a boiler was exhibited under steam, said to be consuming town refuse on the plans of Mons. Fountain Livet, and which was to eliminate the cost of fuel in electric lighting.

The boiler is of the "Elephant" type, with internal flues in the heaters and Galloway tubes, but so far as the boiler is concerned, we could discover nothing uncommon or original. The furnace bars seemed to be on the Vicar's principle, but the firing at the time of the exhibit was by hand. Steam was full up when the party arrived, and the only plant being driven from the boiler was a 32-unit Parsons's steam turbine, working some arc lamps and a search light. This was no adequate work with which to test a boiler of the magnitude shown, and even this small load was not run for any length of time; it is, therefore, impossible for us to say anything regarding the performance of the fires and boilers under a good load and fairly heavy firing. The fires were clear and bright when the party entered, and during the whole visit only a few shovels of town refuse were thrown in from a heap laid out in front of the boiler, and this stuff was pretty dry and in good condition.

We were much disappointed to find that no attempt was made to demonstrate what could be done with the boiler, nor to show that the furnaces would really maintain steam for, say, 200 horse-power firing with this rubbish; in fact, no demonstration of any kind was attempted—all that could be seen was a huge boiler under steam, but doing nothing, and one could easily understand how a few shovels of rubbish could maintain the pressure. But it is only under heavy load and constant firing for some hours that a furnace can show whether it is really performing its duty, and prove that it can deal with the class of fuel being used.

So far, then, as the visit is concerned for the purpose of seeing for ourselves really what the furnace could do with rubbish, it was a failure. We received several documents relating to the apparatus shown, but only one professes to be a report, and it is signed by Mr. Edwin E. Glaskin, M.A.S.C.E. From this document, and the explanations given, we gather that the process proposed consists in using rubbish in a boiler furnace of special construction, and the idea is to use rubbish only at light loads, and to add more and more coal with it as the load rises, so that at all loads under, say, 150 H.P., only rubbish is burnt, and at loads nearly full only coal is employed; at half-load about half coal and half rubbish may be used.

Great importance was attached to the construction of the boiler flues and chimney stack. These flues taper out in area from the fire grate to the chimney; and the chimney, also, is to taper from the bottom, widening as it rises.

The increasing of flue areas as they recede from the fire is an old plan, and as for the chimney, the one in use on the boiler at Halifax was a straight iron pipe, apparently too small for the size of the boiler at full power.

Such an exhibition could only have the effect of making the promoters of the project ridiculous in the eyes of engineers. It neither disclosed what were the inventions, what was novel or original, nor did the display made demonstrate what could be done by the furnaces and boiler shown.

On the question of utilising town refuse in generating steam for electric lighting, there was not the slightest evidence produced to show that the furnaces at Halifax could deal with it at all, and this is corroborated by the statements made that coal is to be employed at heavy loads; in fact, at full load nothing but coal is to be used, and only at light loads is rubbish to be burnt. But with such a scheme it would be impossible to deal with more than a small fraction of any town's refuse, and it has yet to be demonstrated that any boiler furnace can deal with common unsifted rubbish of the kind, no matter how the flues are built.

It will be quite obvious to the most ordinary tyro in these matters that to burn a little refuse when the boiler is doing practically nothing, or at light loads, and to use coal altogether at heavy loads, would neither dispose of all the rubbish of a town, nor make an "enormous reduction in the cost of electric lighting."

Before attempting to interest capitalists and electricians in their projects, the Atlas Contracting Syndicate ought to subject their inventions to rigorous tests, and have the results vouched for by some well-known authority on boilers, furnaces, flues, and steam generating. It would be an insult to the engineers present to expect them to accept the Halifax display as a proof of the claims put forward for the process; the demonstration was little short of an extravagant farce.

CORRESPONDENCE.

Incandescent Lamp Plant.

I beg to enclose the following reply to your Cape-Colony correspondent, but, of course, it is impossible to give a close estimate until the type of lamp and other details are decided.

Arthur Spain.

London, N.W., *February 7th*, 1894.

A complete plant to turn out 250 lamps per day of 12 hours should cost slightly under £1,000, including engine and boiler and a battery of accumulators. The necessary staff would consist of the following skilled hands:—Foreman, glass-blower, pumper, mechanic, and engine driver; also three men or lads unskilled, and nine boys or girls.

The cost of so small a plant is proportionally much greater than of one designed for a larger output—say 1,000 lamps per day. I shall be glad to put your correspondent in the way of obtaining several of the necessary instruments, &c., at a greatly reduced price from a continental firm now closing their works, and shall also be happy to give full details and any further particulars, if necessary.

Electric Light on Shipboard.

Your remarks in your issue of February 2nd are very opportune, and it is to be hoped will have the effect of improving the present unsatisfactory condition of things in this branch of the electrical industry. Owing to absence of expert supervision on the part of the registry offices, wiring on board steamers is frequently carried out in a manner which cannot be too strongly condemned.

Cable and wire, of a quality which no respectable fire insurance office would allow to be used in any class of building whatever, is often met with on shipboard, and that, too, in ships recently fitted. In many instances the method adopted of carrying the cables is open to very grave objections, it being a common practice to use ordinary wood casing in cargo spaces, where the protection afforded should be of the strongest description.

Referring to your suggestion as to the use of armoured cables, these are found to answer fairly well under some conditions, but trouble has occasionally arisen from a leaky deck destroying the wire with which the cable is protected, and, unless the insulating material is lead covered, it rapidly gives way.

For wiring of engine room, stokehold, and other places where damp is often met with, some firms have adopted the practice of using lead covered cables, coated outside with layers of strong tape, and enclosed in galvanised iron tubing, with cast-iron junction boxes at the joints, cables through cargo spaces being of the same description and carried in the same manner, but without joints. This plan appears to give highly satisfactory results, as the fittings being screwed on to the piping is practically watertight, and, should heating occur through a faulty joint, no danger can ensue to any surrounding inflammable material.

The chief objection to this system is the somewhat high first cost, but when shipowners realise that a low priced installation is not necessarily cheap, it is possible that they may see their way to its general adoption.

Marine.

February 12th, 1894.

I should like to propose a few rules, the Board of Trade should enforce, so as to prevent accidents of any description.

These are the following:—1. All ships to be wired on the distribution system (no jointing).

2. No wires or cables to be led through any hold.

3. In cargo steamers the mains to be run on deck in water-tight, galvanised iron pipes.

4. Mains not to be led along the alloway below the beams, but to run inside the state rooms along the frames.

5. All deck pipes should stand 6 inches above the deck, and glands through water-tight bulkheads to have water-tight packing and wooden plugs, standing ½ inch above the nuts.

6. The masthead light to be *fixed* (not portable), and run up outside the mast in galvanised iron pipes.

7. All wires and cables in the engine room and stokehold to be run in water-tight iron pipes with split ⊤ and + joints.

8. All connectors for portable lamps, cargo clusters, &c., to be on the spar deck, in sheltered positions, and supplied with separate switch and fuse.

I don't agree with the proposal of Capt. Froud of having armoured wires all over the ship, as I have found them just as easily damaged in an engine room and stokehold, as unarmoured wire in pine or teak casings, and nothing will stand it but an iron pipe.

Leon H. Cline.

Direct Driving v. Rope Driving.

The letter of Messrs. Willans which you reprinted from the *South Wales Star*, states that the above type of driving is obsolete and inefficient. This I flatly contradict, and give the following figures as good and sufficient reason. They are taken from the Madrid station of the Electricity Supply Company for Spain, Limited, erected by Messrs. Hammond and Co. Six 100-unit plants, consisting of separate boiler, slow-speed rope-driving engine and alternator:—

Three plants were running every evening with loads varying from 1 per cent. to 20 per cent. above rated output for two hours. First engine started at 2 p.m., the others being synchronised in and separated with part of the load, as required, and later were again synchronised in, load taken off, and shut down as the total load fell, the last being shut down at 7 a.m. A fourth plant had full steam up and revolved slowly as stand-by, but was never used except in cases of culpable negligence with the loaded plants.

During the last three weeks of my management there, the coal consumption per unit registered at the station and checked by the ammeter readings every 15 minutes, was 13·5 lbs., costing 0·27 pesetas. A careful test showed the value of the coal as fuel when compared with best Welsh to be only 0·65, the consumption being equal to 8·7 lbs. of best Welsh. This for London at, say 19s. per ton, for long contracts would be 0·88d. per unit registered. This figure would have been reduced had I remained. The above figure is quite up to the average.

The oil and stores bill was equally low. As to wear and tear, one fitter and labourer, with an occasional lift on the crane, did all the work coming under that head. More were employed but an analysis of the log sheets would show them engaged on work that should never have been necessary, due to previous mismanagement. Can any single-acting direct-driving station of six 100 unit plants say as much. Note, too, that each plant in turn, twice a week, was worked well above its rated output. Yet this is the type of plant we are told is obsolete and inefficient. True, the statement was made by a biassed manufacturer of a different type of plant, but having been made, must be contradicted.

I further maintain that the consulting engineer was fully justified in ignoring the day-load plant of the direct-driving type. Speaking from four years' experience with several synchronisations daily during the winter months, it is impossible to avoid occasionally switching in slightly out of phase. A sudden variation of load, a slight sticking of the governors, and many other things, may cause a momentary check to one engine while in the act of switching in, and too late to recover the hand. This causes a violent pull in opposite directions on the two alternators, the lagging machine being pulled forward and the forward machine pulled backward. This, with rope-driving, is taken up by the elasticity of the ropes. But with a direct-driving engine there is no elasticity between piston and machine, and should two such plants be synchronised slightly out of phase, a very heavy strain is put on the crankshafts, and in single-acting engines a dangerous blow on the backstrap. I have heard from various sources of strained crankshafts, broken coupling bolts, &c., through heavy load being thrown on this type of engine suddenly. Perhaps Messrs. Willans can give us some interesting information on this point in connection with Manchester Square, Bankside, and Bristol. With the combination of a large rope-driven plant and a small single-acting direct-driven plant, the result would be very similar, and, sooner or later, the latter would suffer. Were any consulting engineer to specify such a plant for my station, I should refuse to take any responsibility.

Against direct-acting engines in their right place I have nothing. The 85 per cent. and 86 per cent. efficiency diagrams recently published by Messrs. Crompton and Messrs. Siemens are admirable, but what we want more are details of practical work, such as the above.

Given a new plant of 76 per cent. efficiency at full load, gradually rising as it settles to its work, to 79 per cent. and 80 per cent., that can be relied on year after year, without undue wear and tear, and can take an occasional night's work of 33 per cent. above rated output without injury, and we have reached a high commercial standpoint. Get better by all means, if possible, but first make sure that the extr wear and tear, labour, worry (the latter item often the biggest, but not appearing in the accounts), and consequent expense will not rob you of more than the expected advantages.

As Mr. Ruddle so ably put it in his recent letter, the great point is "reliability of running." This I have proved to my complete satisfaction with slow speed rope-driving plant and comparing my experience with what I hear from colleagues who have the direct-driving type, consider it far preferable for alternating current work.

I have since been engaged on a similar station, which, with some disadvantages as regards load, when compared with Madrid, shows proportionately good results.

I therefore beg to ask the writer of the leaderette in your issue of January 12th, *re* the Newport tenders, to withdraw

the statement he made as to none of Mr. Hammond's stations being successful and some the reverse. Any slow speed rope-driven station will show equal results to the above, if properly managed.

To avoid any false inferences, permit me to add that I have never had the slightest mishap in synchronising or parallel working.

Ernest G. Pink.

Another Main Consideration.

In your issue of February 2nd, a leading article appeared under the heading of "A Main Consideration." I regret that many preoccupations and a taste for other literature usually, delayed my perusal of your valued columns, otherwise you should certainly have received a rejoinder for your last issue. After dealing with the published results of open competition for the mains for central station work, you proceed to put certain queries to the official whom you elegantly describe as "the paid expert." You ask him to account for the difference between the highest and the lowest tender, a difference, by the way, which exists with regard to the mains to a far less extent than to that of any of the other plant submitted to competitive tender. You then ask, "Can he satisfactorily demonstrate how additions, tappings, &c., can be made to mains 'insulated' with rubbish which is sealed over with lead?" And you answer, "He cannot, and we protest," &c., &c. The only lead covered cables manufactured in this country, and insulated by materials other than rubber, are those of Messrs. Siemens, in which the copper strand is surrounded by jute and impregnated with an insulating compound, those of the Callender Company insulated by Callender's bitumen, those of the British Insulated Wire Company, insulated by paper strip and layers of insulating compound, and the cables of the Fowler-Waring Company, the insulation of which has a very much higher specific resistance than that of the best vulcanised rubber. The remarks above quoted must have reference to the manufactures of one of the above companies, and it is indeed difficult to determine whether the young man who penned them is the more ill-informed or vulgar.

The tappings and junctions of lead-covered cables are most thoroughly understood by those interested, if not by some of the more reckless of your occasional leader writers.

It is a pleasure after this candid criticism, which you really invite, to cordially endorse your remarks on shipboard electrical work. I have been responsible for the electrical arrangements on a large number of steamships, and for some years of the electrical apparatus on a squadron of war ships in the tropics. I think there can be no doubt that the conditions demand the most excellent materials and workmanship. It is pleasant to note that you advocate the use of concentric iron-sheathed conductors, but it should be added that on board ship all wires should be encased in a hermetically sealed metallic tube, preferably of lead, and that in no instance should vulcanised rubber be used, as it is a material which rapidly deteriorates when exposed to the combined effects of heat and moisture.

Alfred E. Mavor.

Double-Acting versus Single-Acting Engines.

In your impartial and able article on this subject you scarcely attach enough importance, we venture to think, to the distinction between engines which have, and those which have not, to make long continuous runs. We have never doubted the suitableness of double-acting engines, even at high speeds, for certain purposes. Thus for torpedo boats, where lightness is of extreme importance, but where the highest speed is required only for an occasional spurt of a few hours, a single-acting engine would be out of place. Where the wear in the brasses, which can never be far off in a double-acting engine running really fast, can be examined at frequent intervals, and can be corrected from time to time before it assumes dangerous proportions, there is no reason why high speed double-acting engines should not run with safety and with success. It is where continuous running is wanted that the "constant thrust" engine asserts its superiority. In copper depositing works, and in other industries where electrolytic processes are used, the Willans engines are habitually run without stopping for periods ranging from six or seven weeks to six or seven months, and when the run is over no one thinks an overhaul necessary before a fresh start is made. In electric light stations the running is not of course so continuous as this, but the same qualities which give success in the one class of work give success also in the other, and therefore we hold strongly that, for driving dynamos (and for innumerable other purposes) single-acting engines are better than double-acting. If we thought otherwise we should make the latter. One of the most experienced electric light station engineers in this country, after several years' use of the Willans engines on a large scale, said recently, "I never have to think about the engines." That is the sort of testimonial which only a constant-thrust engine (among high-speed engines) can earn.

Your article induces us to offer some remarks upon the letter from Messrs. G. E. Belliss & Co., which appeared in your pages a week before, but which we should otherwise have left to answer itself. The principal points in regard to which they seem to think the Willans engine has received undeserved credit are:—

1. *Economy.*—They suggest that trials at Thames Ditton give results that are not repeated in practice elsewhere. That is not our experience, and we can assure Messrs. Belliss that they are mistaken if they suppose that good results are obtained here by "carefully preparing the slide and piston valve rings so that they may be absolutely tight on trial." The several parts are put together exactly as they leave the lathes and boring machines: they are drawn indiscriminately from store, and if they were found to require "preparing" in any way whatever they would be rejected. We believe that no engine leaves the works which will not give greater economy after six months' running, and we may say that the best results ever obtained with a Willans engine, under given conditions of load and pressure, were from an ordinary G. G. engine employed to light our shops, four years after it was put down. That its rings were both more steam-tight, and, worked with less friction, than at first, is only natural, as in the Willans engine both the end faces of the rings are in constant thrust. It would be otherwise, of course, with a double-acting engine. However, the question is not worth arguing, for Messrs. Belliss's next paragraph seems to lean to the broader view that economy doesn't matter, and that coal consumption is much the same for all types of machine. Happily for us this is not the general opinion.

2. *Durability.*—Messrs. Belliss say truly (*a*) that in the single-acting engine the cylinders must be of double volume, and the pressures on the bearings doubled (or their area) for the same horse-power—but they do not add *at the same speed*, though this is essential. Equal speed of course begs the whole case. The Willans engine came into existence, and then into such wide favour, first, because a high speed engine was wanted: secondly, because when tried, it was found to have other advantages independent of (though derived from) high speed: thirdly, because experience showed that double-acting engines could not, without undue wear and trouble, run at even *half* the speeds at which single-acting engines were proved to be practically free from either. Now Messrs. Belliss tell us (surely with "absolutely no ground beyond their own opinion"), that this experience is wrong, and that double-acting engines may run quite as fast as single-acting, and with apparently better results. Over how many years have they put this to the proof?

They also say of the Willans engine (*b*) "the bearing surfaces are always pressing on the journals in one direction, and anyone who has made frictional experiments on shafts knows what an immense difference this makes in causing wear, as compared with the to and fro action of the double-acting engine."

This is surely trifling with facts of common knowledge. At the Institution, last April, a Willans 60 H.P. engine was exhibited (all but the base), which after the equivalent of about five years' ordinary running in driving our shops, showed no wear which the most careful measurement could detect, in journals, crank-pins, or brasses, and which was still so accurate to gauge that its working parts, including the crankshaft and fly-wheel, were replaced by others from store (made, for the most part, some four years later) with such facility that 64 minutes after the engine was stopped, the shop was restarted with the reconstructed engine. Instances of equally small wear may be produced without end. Of course there have been some cases of wear (out of many

hundreds of engines at work), and they have all been clearly traced to bad quality of lubricant. At this time of day the unsupported assertion that constant thrust is *unfavourable* to durability is at least surprising.

Point (*c*) is also an unsupported assertion, which we may safely pass by.

3. *Steady Running.*—As before, *if equal speeds be admitted*, the greater number of impulses per unit of time will make the double-acting engine the steadier running. But equal speeds are not admitted, while the steady running of the Willans engine certainly is. One of the best Moscrop diagrams the writer ever saw was from a 500 H.P. Willans two-crank engine driving a cotton mill at only 200 revolutions per minute, with a fly-wheel which weighed but a small fraction of that of the engine it replaced. The better governing of double-acting engines is, so far as we know, wholly a myth; we should be pleased to test it.

4. *Quiet Running.*—Here Messrs. Belliss's "patented forced system of lubrication" comes in—an old friend, though doubtless in some new shape. No doubt forced lubrication is an improvement, and lessens the knock through lessening the wear, but surely a system in which there is no knock at all, and practically no wear, is preferable. Messrs. Belliss explain that the knocking of single-acting engines at light loads is due "to the fact" that the momentum of the working parts overcomes the steam pressure, and throws the "working "rods" temporarily into tension, "causing very heavy knocking." As the cushioning of the working parts in the Willans engine is absolutely independent of steam pressure, this state of things never can, and never does, arise. The line of piston *valves* depends upon steam pressure, and at light loads becomes double-acting, and so to a minute extent the eccentric rod and strap will require the same kind of examination and occasional overhaul as in Messrs. Belliss's own engine, but certainly the eccentric will not cause "heavy knocking," and there would be no difficulty in cushioning the valves in the same way as the main working parts, if it were worth while, which it is not.

5. *Simplicity.*—In their comparative table of "component parts" Messrs. Belliss compare their *two*-crank engine with our *three*-crank, though our usual make is two-crank, like their own. However, we use the three-crank form largely, for reasons which have no bearing on the double-acting *versus* single-acting question, and for reasons equally removed from it we prefer tandem cylinders to each crank, rather than high and low pressure cylinders side by side. Hence the greater number of parts. Of course the question is not the number of parts, but the trouble they give. (Messrs. Belliss debit the Willans engine with "compression cylinders." These are the guides common to every engine, made in a particularly simple form, as bored cylinders. Have the Belliss engines no crosshead guides among their "component parts"?). "Simplicity" must include some consideration of the oiling question, and it seems to us that an engine which oils its bearings wholly by the splashing of the parts in an oil-bath *is* "self-lubricating," whereas one which is recommended by its makers because oil is "forced" into its bearings by two oil-pumps, is a good deal the reverse, whatever it may be called. Will a six months' run without stopping suit these double-acting engines, with forced lubrication, and oil-pumps, and say 450 revolutions per minute?

Messrs. Belliss say that trials run at Portsmouth Dockyard "show results considerably inferior to those obtained at Thames Ditton." They might have added that when a remarkable order forbidding us to be present at the trials of our own engines was at last cancelled, and the holders of the "equally careful official trials" were induced to stop up the leaks in the official safety valves and steam pipes, the Portsmouth figures ceased to differ materially from our own.

Messrs. Belliss speak of "the unfortunate history of single-acting engines, when they have had to run under circumstances where great care and supervision could not be given." As our order book for 1893 included over 10,000 H.P. in the form of repeat orders from users who had already experience of the Willans engine, in some cases for a good many years, its history appears to us fortunate rather than otherwise. Messrs. Belliss would seem to think so themselves, for they pay it the homage of imitation; the Willans closed crank chamber now takes its place in the Belliss engine, as does the Willans form of separator, and even the name "central-valve" has been thought to add attractiveness, if not accuracy, to the description of the Belliss engines. The latest improvement in the Belliss dynamo engine (as exemplified by the steam dynamos at Kingston) is the complete absorption of the Willans combination base.

We are glad, Sir, that the question is now in your impartial hands, and is not dependent only upon the arguments of those whose commercial interests are at stake.

Willans & Robinson, Limited.
C. S. Essex, *Secretary.*

THE RECENT LEAKAGE ACCIDENT AT BOURNEMOUTH.

The following is a copy of the report of Major Cardew to the Board of Trade regarding the accident to which we have previously referred in these columns:—

Sir,—I have the honour to report, for the information of the Board of Trade, that in compliance with the instructions contained in your minute of the 8th instant, I have investigated the circumstances connected with the sudden death of a horse at Bournemouth, under conditions which suggested that the cause of death was an electric shock, due to some defect in the mains of the electric lighting company.

The following account of what took place I have collected from the narratives of eye-witnesses.

Between half-past 2 and 3 p.m., on the afternoon of the 8th instant, a station omnibus drew up in the roadway opposite to the entrance to the Imperial Hotel in Meyrick Road, Bournemouth.

As the horses drew up both suddenly fell down.

The driver, William Dean, states that he is certain that the horses did not slip, although there was some melting ice and snow on the road at the time.

The driver got down to attend to the horses, and he was assisted by the following men: John King, fly-driver; W. Brown, fly-driver; T. Binden, carpenter.

All these men, as well as the driver, state positively that when they touched the horses they experienced tingling sensations in their arms and legs, which they attributed to slight electric shock. None of them, however, appear to have been injured by the shock, but the driver's foot was hurt by one of the horses treading on it.

One horse was extricated and set on his legs, which appeared to be partially paralysed at the time; the other could not rise and died in a few minutes.

On arrival at the spot about noon on the following day, accompanied by the borough engineer and the superintending engineer of the Bournemouth and District Electric Supply Company, Limited, I had the ground opened at the place where the horses fell, and the iron cover of a street box, measuring 2 feet 6 inches by 1 foot 6 inches, was disclosed about 9 inches beneath the surface of the road. On lifting this cover it was found to rest on a brick chamber about 1 foot deep, to one end of which was connected a 3-inch iron pipe and to one side a 1¼-inch iron pipe.

The larger iron pipe contained two insulated cables, technically described as 7/20 tinned copper wires insulated with high quality vulcanised rubber to $\frac{1}{10}$th inch thickness, and protected by braided hemp.

The ends of these cables projected to about the centre of the box, and were sealed up with India-rubber tape and composition.

Near these ends two smaller cables of 7/21 tinned copper wires, insulated with similar material, but only to barely $\frac{1}{20}$th inch in thickness, and with braided hemp outside, were joined to the larger ones and passed into the smaller pipe. The larger cables had been connected to the supply mains through fuses, contained in a large subterranean chamber, at the crossing of main roads known as "The Lansdowne," about 70 yards away.

This connection had, however, before my visit, been severed by cutting the cables in the chamber.

The smaller cables merely completed the connection to the transformers placed in the area of the hotel, and were 34 feet in length, and the enclosing pipe was laid at a depth of about 18 inches below the surface throughout.

All the cables mentioned were used for the high pressure supply of 2,000 volts.

There were no signs of any arcing or injury to the cables, or to the lid of the street box, the under surface of which was 5½ inches above the cables, but I noticed that one of the "dead ends" beyond the joint to the small cable was covered on the outside with a slimy moisture, and I had this end cut off for further test.

On testing it subsequently in water with 2,000 volts alternating pressure, however, no fault was developed.

In order to thoroughly examine the cables and the street box, it was necessary to move the former slightly, but they were disturbed as little as possible, and a test was then made of the insulation of both larger and smaller cables together, up to the point where the connection to the mains had been severed at the large chamber. This test made with about 100 volts from a small hand machine gave an insulation resistance of between four and five megohms from the small pipe—a result which did not indicate any serious leak, considering that the cut ends of the cables had not been sealed up, and some leakage from them was to be expected.

On consideration of the matter, however, it occurred to me that possibly the slight movement to which the cables had been subjected, had sufficed to move a small defect in the insulation, away from

contact with the pipe, or that the fault might be such as to give high insulation with 100 volts, but to break down when the pressure was increased to 2,000 volts, so that the fault would not be discovered by the electric test I had made. I therefore requested the electric light company to send for my examination the whole of the cables mentioned so soon as they had withdrawn them from the pipes.

This was done, and a distinct defect of insulation was discovered in one of the smaller cables, with evident signs of sparking and some burning of the insulating material having taken place, I do not think, however, from the appearances, that the whole leakage current could have much exceeded one ampère.

Judging from the results of my investigation, and from the attached copy of the report of the borough veterinary surgeon of the post-mortem examination made on the horse, I have no doubt that the latter did receive an electric shock, and that probably this shock was the determining cause of death, but that, nevertheless, the shock could not have been a very severe one, and I am inclined to attach much weight to the veterinary surgeon's expression of opinion that the dilatation of the heart may have been a pre-disposing cause of death.

In order to further elucidate the above, I attach a rough tracing of the locality in which I have marked the street box (*a*), the small pipe (*b*), and the larger pipe (*c*).

My explanation of the occurrence is as follows:—

In the first place the soil at Bournemouth is of such a nature that it is very difficult to get what is technically known as "good earth." There are alternate layers of sand and clay, and either of these may, under certain conditions, oppose great resistance to the passage of electricity.

The soil in which the street box (*a*) and the pipe (*b*) were placed was a peaty sand, but probably a layer of clay exists at no great distance below.

Secondly, the accident happened during the progress of a thaw, after a very severe frost. Now water in the solid form is not nearly so good a conductor as it is when liquid, and the juxtaposition of masses of thawed and masses of frozen ground may have greatly influenced the direction and amount of current flow.

It is just possible that the small amount of heat produced by the current in the wires contained in the pipe may have determined a more complete thawing of the ground directly above the pipe than in other parts.

Thirdly, the pipe which appears to have been directly charged from the cables was only 34 feet long and 1½ inches in external diameter, and was not metallically connected to the larger pipe but terminated at the brickwork of the street box. Even in soil of a highly conducting nature it would, I consider, be possible to appreciably charge such a short length of pipe by contact with a high pressure electric wire.

Owing to the special conditions above referred to, the potential of the surface of the ground immediately above the pipe appears to have been appreciably affected, and the horse seems to have placed its hind feet upon this charged surface. At the same time one fore foot would be four or five feet distant, and very probably in contact with more freely conducting soil.

A current from the charged to the uncharged, or at any rate less highly charged ground, therefore, passed through the body of the horse.

That any such result as the death of a horse should have followed from so indirect and limited an application of electricity is indeed an extraordinary occurrence, but while the field of enquiry it opens to view must be carefully studied, and any additional precautions which may, after due consideration, be thought necessary firmly insisted upon by the Board of Trade, I do not think there was any appreciable danger to human life in this case.

Experience in many countries has shown that horses are peculiarly susceptible to electric shock, and a horse necessarily, even when at rest, is in contact with the earth at points much farther apart than are simultaneously touched by men, while the iron shoes and nails of the former, and its greater weight, ensure a more perfect contact where it does touch.

These differences are well brought out by the testimony of the men who extricated the horses.

When they touched the bridles they felt a shock, because their feet were resting on the ground about seven feet away from the hind feet of the horses; but no one of them appears to have been conscious of any shock at all except from contact with the horses.

The suggestion that people inside the omnibus might have been injured by an electric shock is quite untenable.

It is, of course, needless to point out, however, that many people's lives may be jeopardised from the result of an electric shock given to a horse, and that on this account alone it is essential that all danger of such an occurrence should be avoided.

I cannot acquit the Electric Lighting Company of blame in the matter. They had warning by their own tests that a defect of insulation existed on this circuit, but they had taken no steps to localise and remove it, although the insulation of the circuit was considerably below one megohm. Also on the very day af the accident, as will be seen from the attached copy of a report from one of the foremen in the employ of the Corporation, they had received a warning of the state of things, which they should at once have attended to.

I must also point out that, in my opinion, the use of such small and thinly insulated wires carrying high pressure currents for electric lighting is most injudicious. The cable which failed on this occasion is apparently exactly similar to that which caused the death of a line man on the House-to-House Company's system over a year ago, and other companies have, I am informed, experienced trouble with cables of this size and description.

In order to prevent any recurrence of similar accidents the company should, in my opinion, take the following steps:—

1. Immediately replace all cables used for high pressure, similar to that which caused the accident, by larger cables, having a thickness of insulation of not less than $\frac{1}{10}$th of an inch of best quality India-rubber, or some equally efficient material.

2. Connect together all the pipes in which high pressure cables are contained, and wrap the cables where they pass through street boxes with a sufficient covering of sheet lead, or encase them in iron cases also connected with the pipes, so that the cables should be enclosed throughout in metal casing in connection with earth over the full extent of the system.

3. Submit to the Board of Trade for approval, as required by Regulation 10, some efficient pattern of leakage indicator.

4. Take immediate steps to localise and remove any defect of insulation which may occur on their circuits.

I have, &c.,

The Assistant Secretary, Railway Department, Board of Trade. (Signed) P. Cardew, *Major, R.E.*

Report of the Veterinary Surgeon.

Bournemouth, *January, 9th*, 1894.

Sir,—I beg to report that acting on your instructions, I have in conjunction with Mr. Goodall, F.R.C.V.S., of Christchurch, and Mr. Blake, M.R.C.V.S., of Bournemouth, made a post-mortem examination of a grey mare, the property of Mr. Melton, which was reported as having died suddenly, January 8th.

We found a bruise extending along the right side of the body from about the 7th to the 12th rib. There was an ecchymosed spot on the corresponding side of the pleura. There was marked hyperæmia of the muscles of the anterior part of the body, the muscles of the posterior part were analmic. The abdominal organs were healthy. The spleen was slightly enlarged, the substance was examined by the microscope and was found to be healthy. The lungs were congested. There was dilatation of the right ventricle of the heart, the valves were normal. The blood was fluid, and black in colour. The brain was healthy. Rigor mortis was present.

I am of opinion that the post-mortem appearances were consistent with death being caused by an electric shock. I am further of opinion that the dilatation of the heart may have been a predisposing cause of the death of the mare.

I am, &c.,

John Druitt, Esq., jun., *Town Clerk.* (Signed) J. T. King, M.R.C.V.S., *Borough Veterinary Surgeon.*

Report of the Foreman.

January 8th, 1894.

Sir,—Carter J. Hooper reports that he went to the Imperial to collect ashes about 7.30 a.m. this morning; when he arrived there his horse became startled as if by shock, and he says that he himself felt the shock of electricity in his legs, also in his arms. J. Scott, assistant ash carter that was with him, reported as above-mentioned to me. I at once sent him to the offices of the Electric Light Company, in the Albert Road, to report the same, which he done (viz.) to some young person that was in charge of the offices at the time.

Mr. Turner. (Signed) W. Elcock, *Foreman.*

BOOKS RECEIVED.

Laxton's Price Book for Architects, Builders, Engineers, and Contractors for 1894. Published by Kelly & Co., High Holborn, W.C. Price 4s.

The Engineer's Year Book of Engineering Formulæ, Rules, Tables, Data, and Memoranda in Civil, Mechanical, Electrical, Marine, and Mine Engineering for 1894. By H. R. Kempe. Published by Crosby Lockwood & Son. Price 8s.

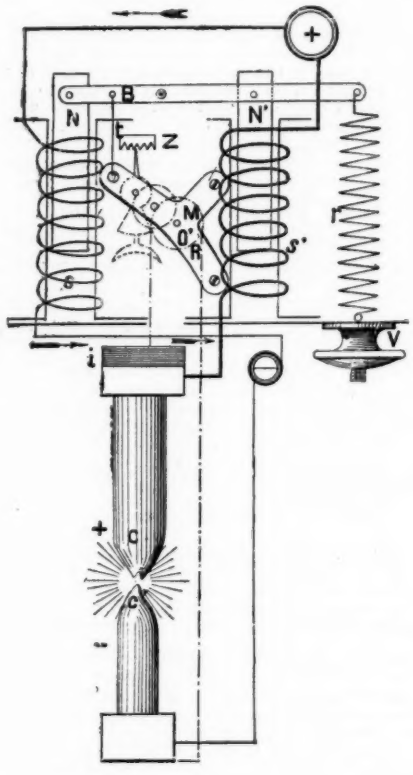
Sell's Directory of Registered Telegraphic Addresses. Published by Sell's Advertising Agency, Limited, at 167, Fleet Street, E.C.

BUSINESS NOTICES, &c.

READY.—The Universal Electrical Directory (J. A. Berly's) for 1894. Orders for copies should be at once placed with Messrs. H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. The price of the book is 4s., post free.

Mill Lighting.—Mr. J. H. Hindle, electrical engineer, Bury, has installed at the weaving mill of Mr. Alex. Barlow, Bridge Mill, near Bury, about 300 lights of various C.P. The dynamo has been supplied by Messrs. Chas. Walmsley & Co., of Elton.—Messrs. Mather and Platt are putting down at one of the cotton spinning mills of Messrs. Haslam & Co., Bolton, a large installation of the light. Messrs. Haslam had the electric light fitted in one of their mills a short time ago, and as it has given entire satisfaction, they have decided to light their other mills throughout by the same method.—The Irwell Bank Spinning Company, near Bolton, are preparing to light their new mill. About 1,200 lights will be required.

The New Japy Lamp.—The arc lamp of Messrs. Japy Bros. & Co., of Beaucourt and Paris, which has long had a reputation on the continent, has recently been considerably improved in minor details, and the makers are now putting it forward in this country as fit to enter into competition with other arc lamps on the market, as regards both the merits of the lamp itself and its low price. The new improved pattern has a fixed focus, requires comparatively a small current, and is very steady. It is simple in construction, strongly made and remarkably compact. It is equally suitable for continuous or alternating current, and for parallel or series lighting, and, having a differential movement, perfect regularity is attained and waste of current prevented, an advantage specially worthy of consideration when the lamps are used two in series. When used for exterior lighting it is provided with a perfectly fitting cover, protecting it from damp and the finest dust. The smaller lamps range from 1·5 to 3 ampères and the larger ones from 3 to 10. The working of the lamp will be seen from the figure. The current coming in at the positive terminal + goes through the thin wire coil, S, returning by the negative terminal −. On the current passing through the coil, the iron core, N, is sucked into



the solenoid, drawing with it the beam which is pivoted on O, the escapement is then released until the carbons come together. As soon as contact is established by the carbons coming together, the main current passes through the thick wire coil, S', sucking the iron core, N', down, drawing up the whole clockwork movement and striking the arc. The balance, B, is then in the position it would be when no current was passing. As the carbons are consumed away, the resistance of the arc increases; more current also flows through the shunt coil of fine wire, S, sucking the iron core, N, further into the solenoid, until the escapment is freed from the rack, Z, and the carbons brought nearer together. When the carbons are brought up to the right distance apart, further feed is prevented by the thick wire coil, S', sucking the iron core, N', a little further in. The feed is so slight, and is made at such frequent intervals, that the arc is practically always maintained at the same length. The carbons are actuated by the brass chain which passes over the cog-wheel, B, the weight of the upper carbon holder giving the motive power to the movement. The spiral spring, r, is to regulate the feed of the lamp, being adjustable by the nut, V. The London address of the firm is 75, Queen Victoria Street, E.C.

Church Lighting.—The Leamington Parish Church, as we have previously stated, has been fitted up for electric lighting. Last Sunday the light was used for the first time. From the central dome depends a 24-light electrolier, and an ornamental 10-light pendant is fixed to the roof of the sanctuary. The nave, transept, side aisles, and choir stalls are lighted by incandescent lamps attached to brackets on the caps of the pillars. Altogether, there are 188 lights, 120 being of 16 candle-power each and the remainder 25 candle-power each. The work, which was designed by Mr. F. W. E. Jones, A.M.I.E.E., of the Midland Electric Light Company, has been very satisfactorily carried out by the Midland Electricity Company, Birmingham. The brackets and pendants came from Glover & Sons, Limited, Warwick. The current will be supplied by the Midland Electric Supply Company, who have agreed to allow the churchwardens a discount of 12½ per cent. off the regular charges.

Messrs. Verity's New Catalogue.—Of the catalogues we have noticed in these columns lately, few have surpassed in point of excellence one just published by Messrs. Verity & Sons. To say the least, it is an exceedingly elaborate and excellent album. It is devoted exclusively to descriptions of electric light fittings, and consists of over 300 pages of descriptive matter, and a number of blank sheets, evidently intended for memoranda of some kind or other, are at the end. With regard to the binding, however, we think the catalogue itself is, on the whole, too good for the quality of the binding; cloth covers, at least, should have been used, if only for the sake of preserving the catalogue for reference. We cannot here enter into details regarding the various fittings that are dealt with, but will mention some of the more prominent. Section I.—Plain single-light brackets. Section II.—Brackets (simple) and others, one to four lights. Section III.—Best ornamental cast brass brackets, one to three lights; also window bar lights. Section IV.—Cast and chased brackets (French style). Section V.—Combination gas and electric brackets. Section VI.—Ceiling fittings. Section VII.—Electroliers, coronal and billiard lights, also combination gas and electric pendants. Section VIII.—Electroliers. In this section there are some elaborately artistic specimens. Section IX.—Flexible cord and brass rod pendants. Section X.—Sliding pendants and shade lamps for offices, libraries, dining rooms, &c. Section XI.—Brass standards for floor, table, and counter. Section XII.—Wrought-iron brackets. Section XIII.—Wrought-iron electroliers. Section XIV.—Wrought-iron ceiling lights, porch, vestibule, and hall lamps. Section XV.—Wrought-iron standards for floor or table. Section XVI.—Fittings for ships, mines, stables, factories, docks, warehouses, &c. Section XVII.—Brackets, lamp-posts, and telegraph poles. Section XVIII.—Reflectors, shades, shop window lamps. Section XIX.—Glass shades (this section is very tastefully got up, the whole being printed in a light green colour.) Section XX.—Also deals with shades, but these are made of silk, paper, and cardboard. By way of variety, this section is printed in a sort of red, which is very effective. The concluding section (XXI.) deals with various electrical etceteras. Messrs. Verity & Sons are to be heartily congratulated upon bringing out such a first-class book; the manner in which the work has been executed is a great credit to the printers, and also does Messrs. Verity great credit, setting forth so exquisitely the multitude of ornamental electrical accessories, of which they are the manufacturers. Members of the trade, and users of electric light fittings will do well to apply for a copy at the firm's establishment at Aston, Birmingham.

Electric Lighting of Victoria Embankment.—The Highways Committee of the London County Council recommended that the work of laying the necessary conduits and forming the refuges round the lamp columns in connection with the electric light installation for the Victoria Embankment, &c., be carried out by the Council without the intervention of a contractor. The chief engineer estimated the cost of this preliminary work at £2,100. Mr. Lloyd moved a reference back. The lamp-posts proposed to be put in the middle of the roadway greatly impeded the traffic, as had been shown in Euston Road. Mr. Beresford-Hope seconded. The embankment was one of the finest thoroughfares in the world, and to put posts in the centre would spoil it utterly from an æsthetic point of view, besides interfering with the traffic. Mr. Bassett-Hopkins hoped the Council would not listen to the arguments of the two previous speakers. To put the posts—which would be handsome columns—on the side paths would add £2,000 to the cost. Mr. Roberts supported Mr. Lloyd's amendment. Was the Council going to spoil the embankment for the sake of £2,000? The posts which had been put up by the St. Pancras Vestry certainly did not add any adornment to the roadway. Mr. Torr thought it was desirable to keep the traffic in two strings, which would be effected by placing the posts in the middle of the road. Mr. Edwin Jones (chairman of the committee) said that, although he was not in love with the scheme, the committee's recommendation was the most feasible. If lamps were placed alternately on each side the illuminating power would be much diminished. After some further discussion the amendment was carried on a vote.

Aberdeen College Lighting.—The existing installation (75 lights) being insufficient for lighting the Gordon's College, Mr. E. T. Ruthven Murray, an electrical engineer, was instructed to report on the matter. His report recommends an installation of 70 incandescent lamps (varying from 8 to 32 C.P.), and two 10 ampère arc lamps. The latter would be sufficient to light the whole of the large elementary room. The engineer suggests that provision be made for the equivalent of 400 16-C.P. lamps to allow for future extensions throughout certain contiguous premises. The governors of the college have since decided to in future take the supply from the Town Council's mains, and to have the Head Master's house and the School of Arts wired also.

Electric Wiring.—Mr. R. F. Yorke's tubular system of wiring is, we understand, meeting with great success. It has been employed in the following installations which Mr. Yorke has carried out:—Installation of 450 lamps at Hollycombe, Liphook, for Mr. J. C. Hawkshaw, the motive power being an oil engine; installation for Mr. J. Carnegie, at Stronvar, water power being used; installation for Mr. W. D. Mackenzie, at Farr House, Inverness, turbine supplied; installation for Mr. Graham Moir, at Leckie, near Stirling, turbine supplied; and at Murthey Castle, which is at present being wired. In each of these instances the insulation is extremely high.

Coventry Electric Lighting.—The City Council have ordered that, as recommended by Mr. Hammond, the culvert carrying the high pressure mains from the generating station to Broadgate be five inches instead of three inches in diameter, to allow for future extensions, the extra cost being £187.

Catalogues, &c.—"Electric Light and Power" is the heading of a new catalogue just brought out by Messrs. Mavor and Coulson, of Glasgow. The opening pages give particulars of the establishments in which the firm have fitted up electric light installations. This list includes a number of public institutions, electric supply stations, newspaper offices, factories, mines, mansions, war vessels, &c. There follows a page of information calculated to be of use to firms desirous of asking for estimates for electric lighting or power plant. If the instructions given are followed out much unnecessary trouble will be saved. Information is given regarding dynamos and motors, illustrated by some blocks which have been cut most skilfully and are very fine specimens; the printing of them and the whole of the catalogue is also a creditable piece of work. The "C.C." system of wiring is described in much detail, as are also conductors, switches, and sundry electrical apparatus. The book is an excellent production.

From Messrs. Pyke, Harris & Co., Limited, we have received several new lists lately brought out by them. The specialities dealt with are small transformers, vacuum tube letters, alternating current dynamos, and the laboratory alternator.

The following catalogues and lists have also come to hand. The "Sunbeam" Lamp Company pamphlet, descriptive of the "Sunbeam" lamps from 8 to 2,000 C.P. Prices are also given. Mackies, Limited, of Reading, illustrated catalogue of specialities, *i.e.*, pulleys, shafting, &c., trucks, pulley blocks, &c., &c., manufactured by them. Priestman Bros., Limited, pamphlet dealing solely with the Priestman oil engine, its simplicity, construction, testimonials, &c.

Claim for an Electric Installation.—The New British Electric Light Installation Company, Worcester, last week brought an action before the Lord Chief Justice at Worcester against Mr. E. Bremner Smith, electrical engineer, Oswestry, and Mr. Charles Fitzroy Somerset, Trederwen, Montgomeryshire, to recover £153, balance of amount due for work done. The defendant Smith applied in April, 1882, for an approximate estimate and suggestions for electrical work for a client of his, and after the specifications had been sent by the plaintiffs, it was revealed that the client was the defendant Somerset, who had a mansion in Montgomeryshire. After the work had proceeded some time Smith sent to Somerset a certificate for £100 on account, and Somerset drew a cheque for the amount and sent it to Smith, who forwarded it to the plaintiffs. A final instalment became due, and again Smith made out a certificate for £153, the amount now sued for. When payment was applied for Somerset repudiated any contract with the company, and said his contract was with Smith. Smith declined to pay, as he was only the agent of Somerset. After the dispute arose Smith amended his certificate for £153 6s. to £138, and that amount the plaintiffs were willing to accept. After further hearing, the learned judge gave judgment for plaintiffs for the £138 agreed upon, and ordered Smith to pay the costs of the plantiffs and of the defendant Somerset. His lordship said it was quite clear to him that plaintiffs were the sub-contractors of Smith, and that Somerset had nothing to do with the plaintiffs, and was brought into the action by the defendant Smith.

Keith, Prowse & Co. v. National Telephone Company.—Justice Kekewich, sitting in the Chancery Division of the High Court of Justice, has delivered a deferred judgment of considerable interest to telephone users. Messrs. Keith, Prowse & Co., a London musical firm, asked for an interim injunction to restrain the National Telephone Company from cutting off the wires supplied to them. The company, it transpired, agreed with the applicants to erect and maintain wires and a telephone apparatus for three years, which ended in June last, there being a clause in the agreement that the company might, upon notice, "forthwith" terminate the supply. Accordingly they gave notice to terminate it on December 30th, but accepted rent up to and including the 31st of that month—one day later. His Lordship, having taken time to consider his judgment, said that whilst it would be impossible for the Court to supervise and determine what was actually involved under the agreement, that difficulty ought not, in the circumstances of the case, to stand in the way of preventing the company from cutting off of the supply. By continuing the service after the expiration of the agreement and receiving rent for a day beyond the period when that agreement was said to be determined, they had waived or abandoned the right to entry, and came under the ordinary law of landlord and tenant. They must consequently be restrained, until the trial or further order, from cutting off the supply, and pay the costs of the application.

Messrs. Baird, Thompson & Co.—This firm have recently acquired the splendid freehold property known as the Charlton Engineering Works, also the property adjoining, together with the machinery and plant contained therein. They are having the same fitted up with all the most recent improvements and labour-saving appliances suitable for their engineering and manufacturing requirements. The Charlton Works, which occupy a large area, are centrally situated, being almost opposite the entrance to the Agricultural Hall, Islington. The whole of the buildings will be lighted by electricity.

The Orient Electric Light Company, Limited.—At an extraordinary general meeting of the above company, held at 43, Finsbury Square, London, on December 7th, 1893, the following special resolution was duly passed; and at a subsequent extraordinary general meeting held at the same place, on December 29th, 1893, the following special resolution was duly confirmed:—"That the company be wound up voluntarily under the provisions of the Companies Acts, 1862 to 1890; and that Robert Wolfenden, of 43, Finsbury Square, in the county of London, solicitor, be and he is hereby appointed liquidator for the purposes of such winding up."

Electric Lighting of Lancashire Town Hall.—The Town Hall is to be lighted with electricity, the details being left to a sub-committee to arrange.

Private Installation.—Messrs. Mather & Platt, Limited, of 16, Victoria Street, Westminster, have lately completed an electrical installation at the house of R. C. Christie, Esq., near Sunningdale, Surrey. The plant consists of a vertical boiler and vertical engine, running at 200 revolutions per minute, and developing 12 indicated horse-power; the same drives a No. 4 Manchester dynamo having an output of 135 volts and 48 ampères, and running at 1,000 revolutions per minute; besides the dynamo, the engine drives a two-barrel slow speed pump, for supplying an overhead tank from a well in the engine house. A set of 54 cells of the patent chloride accumulators, as made by the Chloride Electrical Storage Syndicate, Limited, 16, Victoria Street, has been put in, and the small space occupied by these cells, have enabled them all to be placed in one row in the small accumulator room, which adds greatly to the compactness of the plant. The house, which contains 88 lamps, is situated 180 yards from the engine house, and an underground cable has been laid to convey the current; various outbuildings have also been lit from the same plant, and arrangements are being made to run a water service from the engine house to a large fire tank, containing some 30,000 gallons, distant 750 feet, with a 70-foot rise, and the two-barrel pump will then supply this with water from the well.

The Boudreaux Dynamo Brush Company.—We have received from this company details and price lists of their new foliated dynamo brushes, the particulars of which will be found of interest to practical men, since the wear and cutting of commutators has always been a source of trouble in direct-current machines. Although these brushes have only been in the English market three months, we understand they are much appreciated, and that several flattering letters have been received by the company respecting their superiority over wire and gauze brushes.

Latimer Clark, Muirhead & Co., Limited.—A petition for winding up the above company was, on 10th inst., presented to the Court by Willans & Robinson, Limited, creditors of the said company; the petition is directed to be heard at the Royal Courts of Justice, Strand, on Wednesday, February 21st., 1894; and any creditor or contributory of the said company desirous to support or oppose the making of an order on the said petition, may appear at the time of hearing by himself, or his counsel, for that purpose.

Kendal and Electric Lighting.—Messrs. R. H. Fell and Son intend applying to the Board of Trade for a provisional order, and a representative of the *Kendal Mercury* has interviewed them regarding their proposed scheme for the lighting of Kendal by electricity. Messrs. Fell assert that they will be able to supply the current for motive power at 1½d. to 2½d. per unit, and for lighting from 4½d. to 6d. per unit.

Great North of Scotland Railway.—In our note last week, regarding the new department opened by this company we stated that Mr. Fossette would take charge of same. We now learn that Mr. Fossette has decided not to accept the post, and Mr. L. Legros Horne has been appointed instead to the post of superintendent of telegraphs and electric light. Mr. Horne hails from the electric light department of the General Post Office of London.

Stirling and the Electric Light.—The Board of Trade have insisted upon the Town Council's applying for a Provisional Order to supply the electric light, if it is going to oppose the Caledonian Electric Supply Company's application. A special meeting of the Town Council is to be held to consider the matter. It is only right that the Council should not be allowed to prevent the electric light being adopted without some very substantial reason.

Poole (Dorset) and Electric Lighting.—We understand that a pair of powerful Otto gas engines and a complete Downson gas making plant for lighting the town by electricity, will shortly be erected under the superintendence of Mr. E. R. Dale, Assoc.I.E.E., of Sherborne. It is understood that a large number of the inhabitants have promised to support the undertaking.

Electric Light at Barrow.—Some days ago the refreshment establishment of Messrs. Osborne, Flinn & Co. (Barrow) was lighted by electricity. The installation consisted of 89 incandescent lamps of various candle-powers (8, 16, and 100). The current is derived from a dynamo driven by a gas engine. Messrs. J. R. Thornton & Son have carried out the work.

Newcastle and the Electric Light.—A Special Committee of Newcastle Council, relative to the Corporation undertaking the provision of electricity, was held last week. It was decided to communicate with other towns where the Corporations had sole charge of the electric lighting and obtain particulars regarding the same.

An offer has been made by one of the companies to light Grainger Street with electricity at the same cost as for gas. The matter is to be considered when fuller details are sent in.

"British Locomotives."—The first edition of Mr. Bowen Cooke's work on "British Locomotives" has sold so rapidly that the publishers announce a second and revised edition as almost ready for issue. The same publishers (Whittaker & Co.) announce a work on "Surveying and Surveying Instruments," by Mr. G. A. T. Middleton.

Electric Fire Alarms.—On the recommendation of the Finance Committee, the Acton Local Board instructed the surveyor to make inquiries as to the probable cost of having a system of electric fire alarms and electric calls for the firemen established in Acton.

Margam and Electric Lighting.—The Local Board are asking Messrs. Drake & Gorham to report on the subject of lighting the district by electricity.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ballymena.—March 3rd. The Town Commissioners invite tenders for lighting the town, either by gas or electricity, from August 16, 1894, until May 16th, 1895. Plans, time table, and specification to be seen at the office of Mr. Henry O'Hara, Town Clerk, Town Hall Chambers, Ballymena.

St. Pancras.—March 5th. Tenders wanted for boiler, dynamos, engines, economiser, pumps, &c., for the electricity and destructor stations in King's Road, for the St. Pancras Vestry. Full particulars will be found in our advertisement pages.

Islington.—March 21st. Tenders for machinery, &c., are advertised for by the Vestry. For fuller particulars see our advertisement pages.

CLOSED.

Darwen.—The Corporation of Darwen have accepted the tender of Mr. Thomas Barton, of Blackburn, for a complete generating and distributing electrical plant to be utilised at present for the new Technical Schools, but which is intended to form a nucleus for the lighting of the town. The plant consists of dynamos, also switch and distributing boards, manufactured by Mr. Thomas Barton; installation cables manufactured by Messrs. Siemens Bros. and Co., of London; storage cells, manufactured by the Electrical Power Storage Company, of London; gas engine, manufactured by Messrs. J. E. H. Andrew & Co., Stockport. The whole plant is to be erected upon the same lines as the Blackburn Technical Schools and other public institutions, which have also been carried out by Mr. Barton.

Edinburgh.—The Lord Provost's Committee of the Town Council last week accepted estimates amounting to £24,300 in connection with the electric lighting of the city. The following are the contracts accepted:—Mr. George Sinclair, Leith, for boilers, &c., £6,042; Messrs. Siemens Brothers, Woolwich, for engines, dynamos, pipes, pumps, &c., £15,098; and also switchboard connections, &c., £1,700; Messrs. Crompton-Howell and Company, London, for batteries, £1,400.

Halifax.—The following contracts have been given out in connection with the central station to be erected in Foundry Street: Mason, Thomas Mitchell, Warley, £5,200; joiner, Samuel Greenwood, Boothtown, £728; slater and plasterer, J. Bancroft and Son, £346; plumber and glazier, John Naylor & Son, £180; cast-iron work, John Berry, Halifax, £402; wrought-iron work, James Mackrill, Elland, £841; concrete work, George Greenwood & Son, £590; painting, J. Ackroyd & Son, £82.

NOTES.

Correction.—Mr. Gisbert Kapp asks us to give publication to the following:—"The last issue of the *Electrician* contains a note saying that I am about to leave England in order to accept an appointment in Germany. As such a statement, if incorrect, is calculated to injure my professional position in this country, will you allow me to say that the statement has not been made with my authority, and that the editor of the *Electrician* had not even asked me about its truth before publishing it. It is quite true that I have been offered an important appointment in Germany, but as the negotiations are still pending, the statement circulated by the *Electrician* is certainly premature, and may perhaps yet turn out to be incorrect."

Derby Corporation Lighting. — Under the heading of "Appointments" last week, we stated that Mr. J. Stewart had been appointed engineer, and Mr. A. E. P. Moore assistant engineer. This should read Mr. J. E. Stewart and Mr. A. P. F. Moore. Mr. Stewart, we understand, has power to take on a pupil at the works. Since the opening of the Derby station on October 10th, 1893, there have been connected up 2,600 lamps of 8 C.P., which will be more than doubled during the next two or three months, judging from applications received. There are also at present waiting to be connected up 1,000 lamps. In the various streets of the town there are 37 arc lamps, and shortly, by extensions which are to be carried out, there will be an additional 30 arc lamps.

Harrogate Ratepayers and Electric Lighting.—A formidable host of ratepayers at a public gathering, recently gave expression in resolution form to their disapproval of the Corporation carrying out the electric lighting scheme themselves. A recommendation was embodied that private enterprise be granted the monopoly.

Rubbish on Rubbish.—The newspaper man should leave technical questions involved in new, or alleged new, scientific processes severely alone, at least until the technical press has expressed its views regarding them. The amount of literary rubbish offered to the public in regard to Livet's inventions since the Halifax display is immensely greater in quantity, and worse in quality, than the material rubbish offered to the so-called destructor in that town last Saturday. The *Leeds Mercury* actually states what is absolutely untrue in saying that there are two Livet boilers in use at Kensington Court Electric Light Station in London, and that in one day they consumed half a ton of coal and 17 tons of rubbish, and produced an average horse-power per hour of 259·8 horse-power. Such statements are not only false, but full of mischief. We are perfectly well aware as to how a non-technical pressman has been led into publishing such misstatements. The report on the process, which was handed to the visitors, is so written as to mislead the uninformed ones into the belief that the Livet proposals are being tried at Kensington Court Station. If it were the fact that the Livet process was actually in operation anywhere in London in any electric light installation, the technical press would have published full information on the subject from a visit there, with much greater detail and actual information than could be got on a flying visit to a small private installation in Halifax. That fact alone might have warned this newspaper against making such assertions. The paragraph in the report reads thus in regard to the Kensington Court Station:—

> By the load curve chart of the Kensington Court Electric Station attached hereto, it is demonstrated how, in the Livet generator, the variable load of an electric light station is met step by step in adding energy (coal) uniformly with the increased demand for power. And on page 6 of this report will be found the financial results of an installation producing the same quantity of power as that by coal in the present system with Lancashire boilers, stated on page 7; and showing that with only 27,500 tons of town refuse, and 758 tons of coal, the same quantity of power (viz., 1,610 horse-power per hour) is produced, at an annual saving of £10,254.

The Heilmann Locomotive.—Some very interesting experiments were made last Saturday with M. Heilmann's electric locomotive on the railway between Havre and Benzeville. The representative of the *Temps*, who was present in the electric train with many notabilities, says they travelled from Benzeville to Havre at the rate of 80 kilometres an hour, which is not more than that of the ordinary fast train. The return journey from Havre to Benzeville, notwithstanding a steep gradient which had to be climbed, was effected at the speed of 100 kilometres an hour. The directors and engineers of the company seemed thoroughly satisfied with the result of the experiments.

Newport Tenders.—The Committee, having re-considered the matter of the tenders of Messrs. Fowler and Messrs. Crompton, adhered to their original recommendation. The Town Council on Tuesday, discussed the whole question, with the result that Messrs. Fowler get the contract for the machinery and general work connected with the installation, excepting the cables, which are to be obtained from Messrs. Siemens Bros., and the engines which are being ordered from the Uskside Engineering Company. Messrs. Fowler's tender was accordingly reduced £3,828, to allow for the engines being obtained from the Uskside Company.

The Progress of Civilisation.—Under the heading, "Should civilisation suppress quackery?" the *Hospital* has an admirable article bearing upon the responsibilities of all civilised members of the community regarding quackery, and the necessity for its absolute suppression. The medical profession are exhorted to move as a body to secure this very desirable but hardly-to-be-expected consummation.

Society of Arts.—On Wednesday, February 21st, at 8 p.m., a lecture on "Electric Signalling without Wires" will be given by W. H. Preece, Esq., C.B., F.R.S. Sir Richard Webster, G.C.M.G., Q.C., M.P., will preside.

The Institution of Electrical Engineers.—To-night, at a students' meeting to be held at 28, Victoria Street, S.W., there will be a discussion on Prof. G. Forbes's paper on the "Electrical Distribution of Power from Niagara Falls."

Edinburgh Vacancy.—The Corporation of Edinburgh are inviting applications from gentlemen who have had a thorough training, both as mechanical and electrical engineers, for the post of resident engineer at the electric lighting station. The salary is £300 per annum, and candidates should have had practical experience in central station working, and, if possible, in the laying of electric mains. The latest date for receiving applications at the office of the Town Clerk is February 24th.

Lectures.—On Wednesday last week, Mr. J. Jerritt gave a lecture, illustrated by experiments, at Emmanuel Church House, Plymouth, on "Magnetism, Electricity, and Telegraphy."

Before the Blackpool Scientific Society the other day, Mr. J. Hesketh (Borough electrical engineer), lectured on "Electricity."

Glasgow and West of Scotland Technical College.—The Glasgow University Court, at their meeting on the 8th inst., agreed to recognise the day Lecture and Laboratory Courses delivered by Prof. Andrew Jamieson, on "Electrical Engineering," as qualifying *pro tanto* for Graduation in Science, under Section IV. of the Ordinances regulating Degrees in Science in Engineering.

Islington and St. Pancras Electric Lighting.—The London County Council have agreed that £9,000 be lent to the Islington Vestry towards purchasing a site for an electric lighting station; also that £29,700 be granted to St. Pancras towards the cost of electric lighting works in the parish for 25 years.

The Institution of Electrical Engineers.—On Thursday, 22nd inst., the following papers are to be read:—"On a Method of Testing the Magnetic Qualities of Iron," by Gisbert Kapp, M.Inst.C.E., Member. "A Note on Parallel Working through Long Lines," by W. M. Mordey, Member.

Eccles and Electric Lighting.—Representatives of the Town Council have been appointed to confer with Dr. Hopkinson and Mr. E. Manville on the subject of electric lighting, and report thereon.

Explosion.—About 11 o'clock on Thursday night last week an explosion occurred in the School Electric Light Works, Tamworth. It was found that the man in charge had been burnt about the face by an explosion of gas.

Electric Light in the Solent.—The occupants of the forts in the Solent were busy one night last week in experimenting with the electric light.

Abergavenny and Electric Lighting.—The opinion of an electrical expert is to be obtained regarding the advisability or otherwise of having an electric light installation.

Electric Lighting at Scarborough.—The Town Hall is to be lighted by electricity.

OFFICIAL RETURN OF ELECTRICAL COMPANY.

Anders' Telephone Company, Limited.—In our last issue we stated that the registered office of the above company as 5, Great Tower Street, E.C. We are informed, however, that the correct present address is Telephone Buildings, 31, Queen Victoria Street, E.C.

LEGAL.

ALABASTER *v.* HARNESS.

In the Queen's Bench Division of the High Court, yesterday, before Justices Mathew and Collins, sitting as a Divisional Court, Mr. Banks appeared on behalf of Mr. Alabaster in support of an appeal from the Master and Judge, who held that the defendant Harness's objection to answer certain interrogatories was a good one, on the ground that they might tend to criminate him. Learned counsel, on behalf of the plaintiff, submitted that that was not a good objection, and that the defendant ought to answer. The action was one brought to recover damages for maintaining the action of Tibbits against the ELECTRICAL REVIEW, which was tried before Mr. Justice Mathew. The present action was brought by the proprietors of the ELECTRICAL REVIEW against Mr. Harness and the Medical Battery Company, Limited, for jointly maintaining the action before mentioned. The interrogatories which were administered to the defendant had reference to communications which took place between him and Mr. Tibbits, and with reference to certain payments. His learned friend on the other side took the objection that his client refused to answer on the ground that they might tend to criminate the defendant, he holding that the offence of maintenance was indictable at common law. His (Mr. Banks's) propositions were these: First of all he submitted that his learned friend had not established, and could not establish, upon the authorities, that an action of this kind was indictable at common law. Secondly, assuming that it was, he contended that in this particular case it was in their Lordships' discretion to say that such answers would not really tend to criminate, and that therefore the defendant ought to answer.

After hearing Mr. Dodd, who opposed the appeal, Mr. Justice Mathew said the appeal must be dismissed with costs, on the ground that the Court was unable to say at this stage of the proceedings that the evidence obtained might not be used for the purposes of a prosecution. This was clearly a claim for maintenance and offence, which might be prosecuted criminally. The interrogatories ought not therefore to be allowed. Mr. Justice Collins concurred.

CITY NOTES.

We have to deal this week with a bundle of electricity supply company's accounts, the secretaries of the following companies having been good enough to forward us copies of the annual reports:—Westminster Electric Supply Corporation, Chelsea Electric Light Company, City of London Electric Lighting Company, Charing Cross and Strand Electricity Supply, and Newcastle and District Electric Lighting Company. With one exception, that of the Charing Cross Company, each report gives the number of units sold during the year. This is an admirable practice, and interesting alike to shareholders and engineers; we think that supply companies generally might go a little further and issue a supplementary report, showing the quantity of electricity generated, sold, &c. In this respect, however, the reports before us leave little to be desired.

It is a pleasure to deal with the Westminster Company's accounts, not only because they reveal a pleasant state of affairs, but because the report always provides in the clearest manner minute information on the working of the concern. 98,686 lamps were connected at the end of 1892, and at the end of 1893 the number had been increased to 131,565. On February 7th of this year of grace, 134,268 were connected, and applications had been received for 9,451.

This is a most healthy state of activity, and if the new customers can be supplied without extra plant, the next report should show something handsome. However, we anticipate, and perhaps unnecessarily, for the present report ought to satisfy the most prudent and lynx-eyed shareholder. The sale of current has brought in £41,949 against £34,954 for the previous year; this is worth noting, because it shows an increase of £6,390, notwithstanding the fact that for nine months the price per unit has been 6d., having been reduced from 7d. in April. Competition has not affected apparently the revenue very materially. The increase in revenue has been obtained with an extra expenditure of £3,533, the largest item being attributable to management expenses, which has increased by £1,576, a somewhat large sum. Still, to quarrel with this, would be to make much of little. The net revenue amounts to £12,830, out of which £4,370 has been already distributed as a 3 per cent. interim dividend. The balance of £8,460 will provide a further distribution at the rate of 5 per cent. for the year, £1,190 being carried forward. The following comparative table is interesting:—

	1891.	1892.	1893.
Total capital invested... ...	£329,400	£370,000	**£400,000**
Number of units sold	627,500	1,217,871	**1,704,615**
Number of lamps connected ...	62,820	98,686	**131,565**
Revenue from sale of current...	£19,212	£34,954	**£41,949**
Net revenue	£4,142	£11,608	**15,565**
Average price obtained per unit	7·22d.	6·88d.	**5·9d.**

With an increase of capital of £70,000, the output has been nearly trebled, the number of connected lamps has been doubled, and the net revenue has more than trebled, notwithstanding that the average price per unit has fallen from 7·22d. to 5·9d.

Cost of Production.	£ s. d.	Per unit. 1893.	Per unit. 1891.	Per unit. 1892.
Coal	5,555 11 10	d. ·78	d.	d.
Oil, waste, water, and engine room stores.	1,401 3 4	·19		
Proportion of salaries of engineers' and officers' wages at generating station.	6,765 10 9	·95		
Repairs and Maintenance.				
Buildings (£87); engines, boilers, dynamos and batteries (£1,648); mains, meters, &c. (£765).	2,500 15 4	·35		
Rents, rates and taxes	*2,199 2 10	·30		
Management Expenses.				
Directors' remuneration, salaries of managing engineer, secretary, &c., auditors, law and Parliamentary charges, insurance, stationery, general office expenses and meter department.	6,034 6 3	·84		
Depreciation account, buildings, machinery, &c.	2,963 0 0	·41		
Redemption fund	1,216 0 0	·17		
	£28,635 10 4	4·02d.		

* Deducting balance of rents receivable, and also the amount of income tax on dividends.

Revenue.	£ s. d.	Average price obtained per unit.
By sale of current by meter and by contract (less bad and doubtful debts).	41,949 4 10	5·9d.
Rent of meters	1,847 14 3	...
	£43,796 19 1	5·9d.

The working cost per unit, excluding the debatable item of rent, comes out remarkably low, and the addition of "rent, rates and taxes" brings it to to 2·57d. The total cost comes out at 4·02d. per unit against 4·81d. last year. The figure now obtained is slightly better than that of the Kensington and Knightsbridge Company, whose total cost per unit for 1893 figures out at 4·2d.

The Chelsea Electricity Supply Company makes slow but sure progress. The increase of revenue is not great, but the next best thing to increasing income is to decrease expenditure, and this we are glad to find is the case with the Chelsea Company, for they have sold £2,000 worth of current more than last year, and they have decreased very materially the cost of generation and distribution. The company has sold 45,000 units more than last year, but the coal has cost only £1,863, against £2,433 for 1892. This is an important economy, and the company has fairly earned the right to be congratulated. It is rather surprising to find, however, that there has been considerable reduction of officers' salaries. Increase of output generally means a larger clerical staff, and the inference is that a smaller staff is employed than formerly, or lower wages are being paid. We do not altogether like to see paper economies effected in staff expenses, because either the staff was too large previously, or a false economy is being made by paying smaller salaries. The amount in question is not large, but as we said, increase of staff comes with an increased output, and naturally a differing tendency makes one doubtful of the results. No doubt the company has a perfectly satisfactory answer to this. Repairs and maintenance have been decreased, as will be seen from the comparative table.

The station purchased from the old Cadogan Company, when completed, should prove an important factor in the revenue.

It is proposed to pay a dividend on the ordinary shares of 5 per cent., and a balance of £619 is carried forward.

	1891.	1892.	1893.
Capital expenditure	£74,721	£81,364	£99,483
Units sold...	290,458	357,162	402,848
Lamps connected...	27,500	34,876	*40,665
Revenue from sale of current ...	£9,682	£11,905	£13,078
Average price obtained per unit	...	...	7·7d.

* Deducting number of lamps transferred to the Kensington Company.

The cost per unit for the past three years is as follows:—

Cost.		Per unit. 1893.	Per unit. 1891.	Per unit. 1892.
Coal	£1,863 14 6	1·11	2·22	1·63
Oil, waste, water, and engine room stores and sundries.	595 14 3	·35	·74	·59
Proportion of salaries of engineers and wages at generating station.	1,341 11 9	·79	1·11	·95
Repairs and Maintenance.				
Buildings, £61; engines and boilers, £323; dynamos, £11; instruments, &c., £82.	889 8 10	·53	·93	·71
Rent, rates and taxes ...	805 1 3	·48	·21	·21
Management Expenses.				
Directors' remuneration, salaries of staff, stationery and printing, general charges, auditors, law expenses, insurance, way-leaves.	1,967 18 3	1·17	1·56	1·26
Depreciation account ...	1,000 0 0	·59	...	·67
Total		5·03	6·77	6·02

Revenue.		Price obtained per unit.
Sale of current	£13,078 8 6	7·7
Rental of meters	447 19 8	...
	£13,526 8 2	7·7

We are unable to say much about the admirable balance-sheet of the Charing Cross Company, the directors having decided not to publish the figures which would enable us to see the cost of working.

The company has apparently made considerable progress during the past year, and a comparison of the working costs with those of previous years, and with those of other companies would have been interesting.

34,570 8-C.P. lamps were being supplied at the end of December, an increase of 17½ per cent. on the number supplied at the end of 1892.

It is apparent that the working of the station has been most economical, the management expenses being decidedly low when considering the revenue received for supply of current.

The net earnings have amounted to £8,654; £2,685 goes for debentures, and the rest goes to pay a dividend of 4½ per cent. on the ordinary shares.

Criticism of the accounts of the City of London Company is disarmed by the fact that the machinery on which large sums have been expended is not yet earning revenue. The year 1893 has been a most successful one, if we reckon the economical working of the plant.

The gross revenue for the year was £38,556. Out of this it is proposed to pay another dividend, which will make the total payment 6 per cent. per annum. The working expenses amount to £23,091.

The expenditure on capital account during the year amounted to £260,757.

In order to provide for the additional expenditure which will be necessary to complete the undertaking, the directors propose to issue debenture stock as required. A first issue of £100,000 will be made immediately, and applications from holders of the ordinary and preference shares will be considered preferentially.

Cost of Production for 1893.

	Private supply.	Public supply.
	d.	d.
Coal	1·625	·920
Oil, waste, water, stores, &c.	·246	·542
Salaries of engineers and officers' wages	·926	·952
Repairs and maintenance	·299	·220
Salaries of directors, manager, &c., stationery, printing, &c.	·451	·238
Total	3·547d.	2·872d.

Taking both together, the cost comes out 3·181 against 4·733 for six months' working in the previous year. We shall be abie to do fu justice to these accounts next week.

An 1893 Comparison of Some Supply Companies.

	Capital.	Units sold during 1893.	Lamps connected.	Revenue from sale of current.	Average price obtained per unit.	Works cost per unit (exclusive of rent, rates and taxes).	Total cost of producing a unit.
Westminster Electric Supply Corporation	£400,000	1,704,605	131,565	£41,949	5·9d.	2·27d.	4·02d.
Chelsea Electricity Supply Company	£99,483	402,848	40,665	£13,078	7·7d.	2·78d.	5·03d.
City of London Electric Lighting Company, Limited	£799,610	1,741,099	65,341*	£37,156	7·56d.*	3·096d.	3·547d.*
Charing Cross and Strand Electricity Supply... ...	£211,200	...	34,570	£20,827	...	...	...
Newcastle and District Electric Lighting Company ...	£44,278	388,422	4,000 (10 C.P.)	£6,880	4·25d.	...	3·01d.
Kensington and Knightsbridge Electric Lighting Co...	£174,260	724,308	64,529	£20,746	6·8d.	1·88d.	4·2d.

* Refer to private supply.

The Newcastle and District Electric Light Company have increased their output from 290,469 units to 388,422, an increase of 4,000 lamps, bringing up the total to 18,500.

The gross earnings during the year amount to £2,949, and after paying interest, and making provision for reserve fund and depreciation, and writing off £100 from formation expenses, a dividend of 3 per cent. is to be paid, which, with the interim dividend paid in July last, makes the dividend 5½ per cent. for the year.

Cost of production.	£	s.	d.	Per unit.
Coal, stores, water, oil, &c.	1,794	0	6	...
Wages, salaries, rent, rates, taxes, and directors' fees	2,045	17	1	...
Repairs and Maintenance.				
Repairs and renewals	233	12	5	...
Stationery and office expenses	198	6	8	...
Depreciation	600	0	0	...
Total	£4,871	16	8	3·01d.

As these accounts are not in the usual form, we are not able to work out the cost of the various items, &c. Perhaps, with the help ot Mr. Patterson, the secretary, we will do so later.

The revenue side of the accounts comes out as follows:—

Revenue.				Average price obtained per unit.
By sale of current	£6,880	17	7	4·25d.
Meter and transformer rent ...	339	16	4	
Total	£7,220	13	11	4·25d.

India-Rubber, Gutta-Percha and Telegraph Works Company.

The thirtieth ordinary general meeting of this company was held yesterday at Cannon Street Hotel, Mr. S. W. Silver, presiding.

In moving the adoption of the report, the Chairman said that at the last meeting he held out favourable prospects for the year 1893. Since then they had that much-to-be-deplored struggle with the colliers; that had interfered with the operations to a certain extent, exercising an effect upon their working expenses. The steamer that returned from laying the cable on the West Coast of South America brought back several hundred tons of coals which had been found useful at their works. After further comments regarding the coal strike, he said that during the year they had done something in submarine telegraph work. They had further a contract to light the City of Brussels with electricity, and it was done in a way much to the credit of Mr. Gray's youngest son who, along with Mr. Russell, had had charge. It had proved a complete success. All these things meant that more capital was required, looking at the way in which their money was invested in works, in stock, and in other ways; hence in the best interests of the shareholders to put the company into a position to purchase on the most favourable terms, they had determined on recommending a further sum to be placed to reserve. The stagnation of trade had enhanced the competition they experienced and increased their difficulty in doing good business. There was plenty of business to be done, but the difficulty was to select that which was not likely to prove unprofitable in any way. The greatest care and caution had been exercised by all in connection with the concern. The year, he thought, was specially satisfactory. He then formally moved that a dividend of 5 per cent., and a bonus of 2½ per cent., free of income tax, which, with the interim dividend of 5 per cent. already paid, made 12½ per cent. for the year, be declared. Some shareholders asked questions regarding the availability, or otherwise, of the reserve fund (£450,000) in the event of a bad year. The chairman, replying, stated that the whole was actively engaged in the business, but £270,000 of it was available for dipping into if required. The investments were reckoned at the Stock Exchange quotation at the end of the year.

Mr. Abraham Scott seconded the resolution, which was carried unanimously.

The retiring directors, Messrs. Scott and Henderson, were re-elected, as was also the auditor, Mr. J. F. Clarke.

Mr. Matthew Gray (the managing director) here made a few remarks regarding the general operations of the company. The Brussels central station, he said, was the best central station he had ever seen. The work had given every satisfaction to the authorities, and it was likely they would shortly go in for considerable extensions of the system. He (the speaker) visited Brussels, and also the works of the company in France, which he found in excellent working condition, as were, of course, the Silvertown works as well. The stocks and the value of the works had been very carefully looked into for the last 20 years, and they are still in a very healthy state.

The usual vote of thanks terminated the proceedings.

Liverpool Overhead Railway.

The ordinary half-yearly meeting of the shareholders of the Liverpool Overhead Railway was held at the Law Association Rooms, on Tuesday last, Sir W. B. Forwood presiding over a numerous attendance.

The Chairman said:—The report you have taken of the first complete half-year of the company, brings it down to December 31st last. From this report you will see that the gross earnings for the six months amounted to £18,518 4s. 7d., to which must be added £3,293 balance brought forward, making the total available sum £21,811 11s. 2d. Deducting from this working expenses for the half year £13,732 11s. 2d., interest on debentures, and also interest on calls paid in advance, we have left over the sum of £5,452 available for dividend. Out of this your directors propose, subject to your approval, to pay a dividend at the rate of 5 per cent. on the preference shares, and at the rate of 1 per cent. on the ordinary shares, which will leave a balance of £2,598 7s. 1d. to be carried forward to the next half-year. The total number of passengers carried reached 2,475,639. The dock omnibuses are probably carrying at the rate of 2,500,000 per annum, so that we have a total traffic of about 7,500,000, against 2,300,000, the number carried by the dock 'buses before the railway was opened. Thus, during the first year of the railway's existence the dock traffic has increased threefold, which in itself is a most encouraging feature. You will notice that during the half-year we have run 46,429 trains, and of these 95·35 per cent. have been on time. At first sight it may appear to you that we have spent more money during the past half-year. This arises from the fact that during a considerable portion of the first half we only ran a ten-minutes' service, and, therefore, our locomotive expenses were lighter and we had no charge for general maintenance and depreciation of machinery, which in our second half absorbed £1,730 9s. 10d. Making these corrections the cost of working comes out precisely the same in both half-years. You will, however, notice that it is over 72 per cent. of our receipts, which looks large as compared with the experience on ordinary English railways, but this test is a fallacious one. If our fares were equal to those charged on ordinary English railways our income would be very much larger, and the ratio of expenses greatly reduced. A better test is to compare our cost of working with the South London Electrical Railway. Our cost works out 1s. ½d. per mile, and the South London 1s. ⅝d. per mile. We hope still to make further economies, and I may mention in this connection that we have taken over the generating station, and that our saving during the first month amounted to £150. The extension to Seaforth will be opened in March, and we have contracted for the erection of three new stations.

The report was adopted.

The Chairman next proposed the payment of dividends at the rate of 5 per cent. per annum on preference shares, and 1 per cent. per annum on ordinary shares, less income tax, and that the balance on the net revenue account, be carried forward. He hoped that this resolution was the forerunner of many of a still more gratifying character.

Mr. G. H. Robertson seconded the motion, which was carried.

Mr. S. S. Bacon proposed the re-election of Mr. James Barrow as a director. He should like to remark that he had scarcely expected to have a dividend even of 1 per cent. to begin with, having thought they would have had to wait a much longer time.

Mr. Singlehurst seconded the resolution, which was carried.

Newcastle and District Electric Lighting Company, Limited.

The seventh ordinary general meeting of this company was held on 12th inst., at the offices of Messrs. Leadbitter & Harvey, 57, Westgate Road, Newcastle. Mr. J. D. Milburn presided.

The report, which was submitted, stated that the installations connected to the company's mains during the year were equal to 4,000 10-candle-power lamps, bringing the total up to about 18,500, and 388,422 units of electrical energy had been supplied, as against 290,469 units supplied in 1892. During the past year 3,308 yards of main and branch piping had been laid, together with 6,579 yards of main and branch cable. The gross earnings during the year amounted to £2,949 12s. 3d., and the directors recommended a dividend at the rate of 3 per cent. for the half-year ending December 31st, less income tax, which, together with the interim dividend paid in July last, makes the dividend 5½ per cent. for the year.

The Chairman, in moving the adoption of the report, said that during the year they had had an increase of nearly 100,000 units of electrical energy. That came partially from the North-Eastern Railway Company, at the station and other works, but also to a large extent from individual consumers. That must be looked upon as very satisfactory, because the more work they got to do the more it consumed of their standing charges, and the more profit, up to a certain degree, it allowed them to make. They had been able to effect considerable economy in coal consumption. The drift to the river, and the condensing plant, introduced by Mr. Parsons, had been a very great success, notwithstanding that the cost had been greater than they had anticipated. They had gone into the question of the utilisation of the town refuse as fuel, and it was found possible not only to do a good deal with the fuel, but also to set up a paper factory alongside the works. But Mr. Parsons, who had gone into the matter thoroughly, pointed out that, with duff coal at 3s. or 3s. 2d. per ton, very little economy could be got with anything of the kind. The fuel was all very well, it would burn, but it took a lot of labour to shovel it on to the fires; and if they could get their boilers singing away at full pressure with coal as low as 3s. 2d. per ton, they could hardly go into a question such as that. It was calculated in electric lighting that 6d. per unit was equal to 5s. per 1,000 feet of gas. But the more they had the opportunity and experience of knowing how the light was used the more they were convinced that a great deal of waste took place in electric lighting. Now that the new lamps had come in, this had, to a certain extent, disappeared. They found that a consumer put in exactly double the size of a lamp he required, and then ran it to its death, with the result that at the end of two or three months he got out of it only two-thirds or a half of the power of the lamp, and paid all the same his bills for the big effulgence he ought to have had. It would be found great economy, after using the lamps three months, to take them out and destroy them, and put in fresh ones; and people who had had 25 C.P. lamps, if they removed them and replaced them by 16 C.P. lamps, they would probably find no difference in the light, and pay very much less. There was the question of the reduction of their own price. They did not feel quite yet that they could recommend it; they had had no complaints. Gradually their customers were waking up to the better use and idea of the economy of the electric light, and they hoped that that would popularise the idea of the light. They had recommended the same dividend as last year. Probably they might have done a little more, but they felt that they might some year have their drawbacks, and they might have some bad luck; and it was only right that they should be prepared for that. The feeling of the directors was that they should not go backwards. If they got 6 per cent. this year, it would not be pleasant for the shareholders to go back to 5½ or 5 per cent. another year.

Sir Benjamin Browne seconded the adoption of the report, which was unanimously carried.

Mr. Milburn and Mr. Parsons, the retiring directors, were re-elected, and Messrs. Strachan & Co. were reappointed auditors.

Central London Railway.

A special general meeting of the Central London Railway Company was held last Friday at 30, St. Swithin's Lane, for the purpose of submitting to the proprietors a proposed Bill in Parliament, entitled: "A Bill to extend the time for the purchase of lands for and for the completion of the Central London Railway, and for other purposes."

Mr. F. A. Lucas, who presided, moved a formal resolution approving the Bill, this being seconded by Mr. H. Smith.

Mr. W. Morris (the solicitor) said the object of the Bill was to extend the time for the purchase of lands and the completion of works under the two Acts of the Central London Railway Company. The first Act, that of 1891, authorised the construction of a railway from Shepherd's Bush to Cornhill, with the terminal station in Cornhill. By the Act of 1892 that terminal station was abandoned, and the construction of a central station in the open space between the Mansion House and the Royal Exchange was authorised, together with the extension of the line to Liverpool Street, with power to construct a terminal station under the existing Liverpool Street station of the Great Eastern Railway, thus authorising a through main line from Shepherd's Bush to Liverpool Street, with a central station opposite the Mansion House. In consequence, however, of their having two Acts of Parliament, the time for acquiring the land and completing the works expired at different periods in respect of the different works authorised by the two Acts. This was found to be highly inconvenient, because the whole of the line was, as was obvious, one complete line. There still remained considerable time, but as a measure of precaution, and also as a matter of convenience, it had been thought desirable to apply to Parliament to extend the respective times, and to make the times for taking the lands and completing the works apply to both sections of the undertaking. The Bill now under consideration provided that the time for purchasing land in respect of the whole undertaking should be extended until 1897, and for completing the whole of the works until 1900. It had been suggested that, in consequence of a paragraph that by inadvertence appeared in a newspaper some time ago, he should state that there was nothing whatever in the Bill to alter the mode of traction intended to be adopted on the railway. The only traction authorised was electricity, and it was intended to adhere to that.

The Bill was approved.

Cuba Submarine Telegraph Company, Limited.

The directors' report for the half-year ended December 31st last, presented at the forty-fifth ordinary general meeting of shareholders, held at 58, Old Broad Street, E.C., on Wednesday last, reads as follows:—

"From the accounts accompanying the report it will be seen that the gross receipts (including the balance brought from last account) amount to £23,229 1s. 6d, and the gross expenditure to £5,069 16s. 6d., leaving a sum of £18,159 5s. to the credit of revenue account. Of this the sum of £1,500 has been set aside as a further reserve against any loss from the deposits with banks, and £5,000 added to the reserve fund, making that fund £105,000. The dividend on the preference shares will absorb £3,000, and leave £8,659 5s., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £2,259 5s. being carried forward to the current half-year, against £2,002 7s. 6d. at the end of the previous half-year. The cables have continued in good order throughout the half-year, with the exception of a part of the original cable laid in 1870, between Batabano and Cienfuegos, which gave out at the end of last month; the other portion of the same cable, between Cienfuegos and Santiago, was abandoned 13 years ago. In consequence of the decayed state of the sheathing, its effectual repair, without renewing the greater part of it, is impracticable, and it has therefore been decided not to spend any more money upon it, but to put down a new cable, the cost of which will be charged to the reserve fund. The position of the company's suit against the Spanish Government at Madrid remains the same as at the date of the last report."

The forty-fifth ordinary meeting of this company was held on Wednesday last at 58, Old Broad Street, under the presidency of Mr. Thomas Greenwood.

In moving the adoption of the report, the Chairman said the directors were pleased to be able to present so satisfactory a report. The depression in trade, which had so materially affected such a large number of industrial undertakings, had had some influence upon the receipts of the company. Comparing the traffic receipts of the past half-year with those of the corresponding period of 1892, there appeared to be a reduction of £1,122. This was not due in any sense to the reduction of rates, for these had not yet been made, but to the exigencies of trade The net receipts for the half-year were only £787 less than in the corresponding period.

Mr. Charles W. Parish seconded the motion, which was carried unanimously.

Dividends at the rate of 10 per cent. per annum on the preference shares, and 8 per cent. on the ordinary were declared.

Oriental Telephone and Electric Company.

The directors have issued notice of a meeting to consider resolutions for reconstruction. "It is proposed that there shall be one class of shares of £1 each fully paid up; that the ordinary shareholders shall receive one such share for every two shares of 11s. paid; that the holder of fully-paid shares shall receive the above shares at the rate of 18 for every 20 now held by him, and the holders of vendors' shares shall receive such shares in the proportion of 15½ for every 20 shares now held by them. The paid-up capital of the company will thus be reduced to £171,497, in place of £199,746 as it now stands; the ordinary shareholders will be relieved from all liability as to calls, and the holders of vendors' shares will come in for immediate dividend. All arrears due to the ordinary shares to be cancelled, and the company to pay the cost of the recent litigation."

Babcock & Wilcox, Limited.—The directors have declared an interim dividend for the six months ended December 31st., at the rate of six per cent. per annum on the preference, and ten per cent. per annum on the ordinary shares, payable on February 16th.

Brush Electrical Engineering Company, Limited.—The transfer books of this company will be closed, both for debenture stock and preference and ordinary shares, from February 20th to March 5th inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 11th, 1894, amounted to £937; week ending February 12th, 1893, £952; decrease, £15; total receipts for half-year, 1894, £5,727 corresponding period, 1893, £5,862; decrease, £135.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 9th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £3,007.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 7th.	Closing Quotation, February 14th.	Business done during week ended February 14th. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	...	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	42 — 44 xd	43 — 45	43⅞	...
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	79½—80½ xd	80½— 81½	81¼	80
2,932,680£	Do. do. Defd.	Stock	...	...	...	7¼— 7⅝	7¼— 7⅝	7⅝	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½ % §	6½ % §	11½— 12	11½— 12	11 15/16	...
18,700£	Do. do. 5 % Bonds	100	...	...	...	99 —102 xd	99 —102	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10% ‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	135 —145	135 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½ % §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	11½— 12½	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½ %	4 %	...	2½— 3½	2 — 3	2½	2¼
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8½— 9½	8½— 9½	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §	3½ % §	...	10 — 10¼	10⅜— 10⅝	10⅝	10½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½ % §	6½ % §	...	14⅞— 15⅛	14⅝— 15⅛	15⅛	14⅞
70,000	Do. 6 % Pref.	10	6 % §	6 %	...	15¾— 16⅛	15⅞— 16¼	16⅛	15⅞
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —109 xd	106 —109	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	114 —117	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	...	15½—15⅝	15½— 15⅝	15⅝	15⅝
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	101 —104	102 —105	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	101 —104	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	113 —116 xd	114 —117	115⅛	115
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	101 —104	102 —105	102⅛	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	101 —104	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	102 —105 xd	102 —105	104½	103
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	106 —109%	105 —109%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5½ % §	4⅞ % §	4⅝ % §	8⅜— 8⅝	8½— 8¾	8⅝	8½
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅛— 15⅜	15⅛— 15⅜	15⅜	15⅛
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜ % §	...	21½— 21⅝	21⅝— 22¼	22	21⅝
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	41 — 44	42 — 45	43	42
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	106 —109	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	⅛— 1½	⅛— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	2 — 3	2 — 3	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅜— 5	4⅜— 4⅞	4⅞	4 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14½— 15½	15 1/16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	14⅝	14 7/16
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5¼— 5½	5¼— 5½	5⅝	...
925,017£	Do. 4½ % Deb. Stock Prov. Certs.	...	...	...	...	112 —114	113 —115	114	112¾
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid	1	2¼%	3⅜%	...	⅛— ⅜	⅛— ⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	101 —104	102 —105	103½	102½
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	113 —118	113 —118	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	...	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	101½	101
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 2½	2 — 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	97 —101	97 —101	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	6½— 7	6½— 7	6 15/16	6⅞
33,129	Do. do. do. 5 % Cum. Pref.	7½	...	...	...	5½— 6	5½— 6	...	...
33,129	Do. do. do. do. 5 % Def.	7½	3 %	...	...	1⅞— 2¼	1⅞— 2¼	2	1⅞
178,200£	Do. do. do. 6 % Debs. "A," 1910	100	...	...	...	102 —105 xd	103 —106	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	102 —105 xd	103 —106	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1 — 1¼	1 — 1¼	1 3/16	...
34,563	Do. do. do. 6 % 1st Pref.	10	...	...	...	9½— 10	9½— 10	10	9⅞
4,669	Do. do. do. 6 % 2nd Pref.	10	...	...	...	8½— 9½	8½— 9½	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	105 —108	105 —108	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	...	...	...	113 —118	113 —118	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	...	4½— 5	4½— 5	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	11 — 11½	10½— 11½	11 3/16	11
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	...	12⅝— 13¼	12⅝— 13¼	13⅛	12⅝
19,900	*Electy. Supply Co. of Spain, 101 to 20,000	5	...	...	...	... ...	... ...	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	...	...	...	4⅜— 4½	5½— 5⅝	5⅝	5⅜
15,000	Do. do.	5	4½%	5 %	...	6½— 6⅝	6½— 6⅝	6¼	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000	10	1 %	2 %	...	8 — 8½	8 — 8½	8⅜	8¼
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	104 — 108	104 —108	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5½	4½— 5½	5	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	5⅝— 6¼xd	6¼— 6⅝	6⅝	6 5/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	7⅝— 8¼xd	8 — 8½	8 5/16	8
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	...	3½%	4 %	5½— 6	5½— 6	5 15/16	5⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, February 7th.	Closing Quotation, February 14th.	Business done during week ended Feb. 14th, 1894. Highest.	Lowest.
90,000	Brush Elect. Engine. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2¾ — 2¼	2⅝ — 2⅞	2 13/16	2 1/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛ — 2⅜	2⅛ — 2⅜	2 3/16	...
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	104 —106	104 —106	...	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	28 — 33	27 — 32 xd	30	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3 — 4	3 — 4	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	96 —101	96 —101	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼— ⅜	¼— ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½— 1⅝	1½— 2	1⅝	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	⅛— ¼	⅛— ¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	⅜— ⅝	½— ⅝	11/16	⅝
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	⅛— ¼	⅛— ¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1⅛	½— 1⅛	...	...
12,134/	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4¼— 5½	4¼— 5½	...	...
9,600/	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	24 — 25	24⅛	23⅛
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	...	...
11,334	International Okonite, Ltd., Ord , 22,667 to 34,000 ...	10	5 % §	...	...	1 — 2	1 — 2	...	...
37,500	Liverpool Overhead Railway, Ord.	10	...	...	...	5 — 5¼	4⅞— 5⅛	5 3/32	5
6,295	Do. do. Pref., £8 paid	10	...	...	...	8¼— 8½	8⅜— 8½	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½%	2 — 2¼	2 — 2¼	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 % §	42 — 44	42 — 44	43	41½
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	..	...	... ...	... ...	...	...

† Unless otherwise stated all shares are fully paid.

¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅞.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1¼.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅞—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅞.
Liverpool Electric Supply, £5 (fully paid), 6⅛—6¾.
Do. do. £3 10s. paid, 4⅛—4¾.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Manchester Edison and Swan Company, £9 (£1 paid), ½—⅝.
Queen Anne's Mansions Lighting and Heating 6 % £100 Debentures, 101—108.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅞.

Bank rate of discount, 2½ per cent. (February 1st, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Some Notes on the Electric Lighting of the City of London.

(*Read by Major-General Webber on February 8th*, 1894.)

To the industry generally the history of the inception, and of what led up to the accomplishment, of the public lighting of the streets of that part of the metropolis known as the City of London may have, for several reasons, a special interest, and be worthy of record.

By those who may not already know it, it should be understood that the Commissioners of Sewers hold a similar position, and have similar powers to those that were possessed by the Metropolitan Board of Works and by the London Vestries before the London County Council came into existence; in fact, they are the local authority, possessing jurisdiction distinct from that of the Corporation, the Common Council, the Bridge House Committee, and such bodies; having the direction and control of expenditure on works, for which purposes their engineer and surveyor is Mr. William Haywood, C.E., a gentleman distinguished no less as a colonel of volunteers, late and for many years commanding the 1st London Rifle Volunteers,* than as an engineer.

I think there is a good deal in which the question of what led up to the lighting of the City by electricity so much differs from ordinary cases, that a slight sketch of its history—which has never, I believe, been published—is not out of place on the present occasion. The City is at the head of our municipal institutions, both as regards antiquity, wealth, and organisation. From an imperial point of view, it is regarded as the heart of the commerce of the world. In respect to public lighting by electricity, I believe I can show you that it also has taken the lead.

In 1878, when the Municipality of Paris celebrated the International Exhibition of that year by lighting the Avenue de l'Opera with Jablochkoff lamps, run with Gramme machines by the Société Générale d'Electricité, Mr. William Bassingham, deputy-chairman, and Colonel Haywood, engineer of the Commissioners of Sewers, severally reported to the Streets Committee, in such detail, and in such terms, as to ensure the question never being dropped until the accomplishment of the results which we can nightly witness at the present time.*

It is nearly 15 years since the date of those reports—years that have been momentous to all of us electrical engineers.

Colonel Haywood's report could not have dealt more exhaustively with the question, subject to the difference in knowledge at the present day, than if it was now to be compiled. He pointed out that no section of the metropolis was more interested than the City in obtaining an efficient illuminant, for, within its boundaries, the Gas Light and Coke Company then collected a rental of £370,000 per annum.

No doubt that example of street lighting in Paris induced the commissioners to take up the subject. The 64 electric lamps in a thoroughfare 980 yards in length, placed 30 yards apart on alternate sides, were said to give a nominal candle-power of 20 times that of the 300 gas lamps previously used, allowing that one Jablochkoff candle gave 100 times as much light as a gas-burner using 12-candle gas at 5 feet an hour.

The cost price of these lamps (estimated then at 6d. an hour, as they were extinguished at midnight) was £50 a year each, which, for 64 lamps, came to £3,200 a year, as against the cost of the gas lighting during the same hours, which came to £1,200 a year at 5 centimes per gas lamp an hour.

Colonel Haywood at that time considered that the Avenue was lighted "vastly in excess of all reasonable requirements;" and although he went no further than stating that in his opinion there were places in the City—such as by King William's Statue, in front of the Mansion House, and in the Circuses—where the convenience of the large traffic "might justify the expense of employing the electric light during the busiest hours of darkness," he nevertheless recommended the commissioners "that as early as possible an ample experiment be made by lighting with electricity during the winter months of 1878 one or more of the public thoroughfares within their jurisdiction."

In consequence, in November, 1878, the same company commenced lighting the Holborn Viaduct with 16 Jablochkoff lamps, placed

* Colonel Haywood joined the corps in 1859 as a private, and rose through each rank to be Lieut.-Colonel in 1876, and retired from that position in 1882.

* As international juror for telegraphs and allied electrical applications of that year, my notes on the installation show that the Avenue and Place de l'Opera, and the Place du Théâtre Français, only represented a small fraction of the application of the Jablochkoff lamp then running in France.

about 110 feet apart. They were run from sunset till midnight, replacing 86 gas lamps.*

The results arrived at after three winter months' work were, that, while only doubling the light (allowing a loss of 50 per cent. with the globes) of the 86 gas lamps, the cost—namely, 5·73d. per hour—of 16 Jablochkoff lamps was four times that of gas at ½d. an hour.

The discouragement produced by this experiment only continued for one year, and in the spring of 1880 the commissioners (at the instigation of several members whose names have since been connected with improvements in lighting the City) again decided to renew experiments on a more extended scale by lighting (see streets shaded black on map, Plan No. 1) New Bridge Street, Queen Victoria Street, Queen Street and Queen Street Place, King William Street to the Bank, Poultry, Cheapside, St. Paul's Churchyard, Ludgate Hill, New Bridge Street and the Bridge.

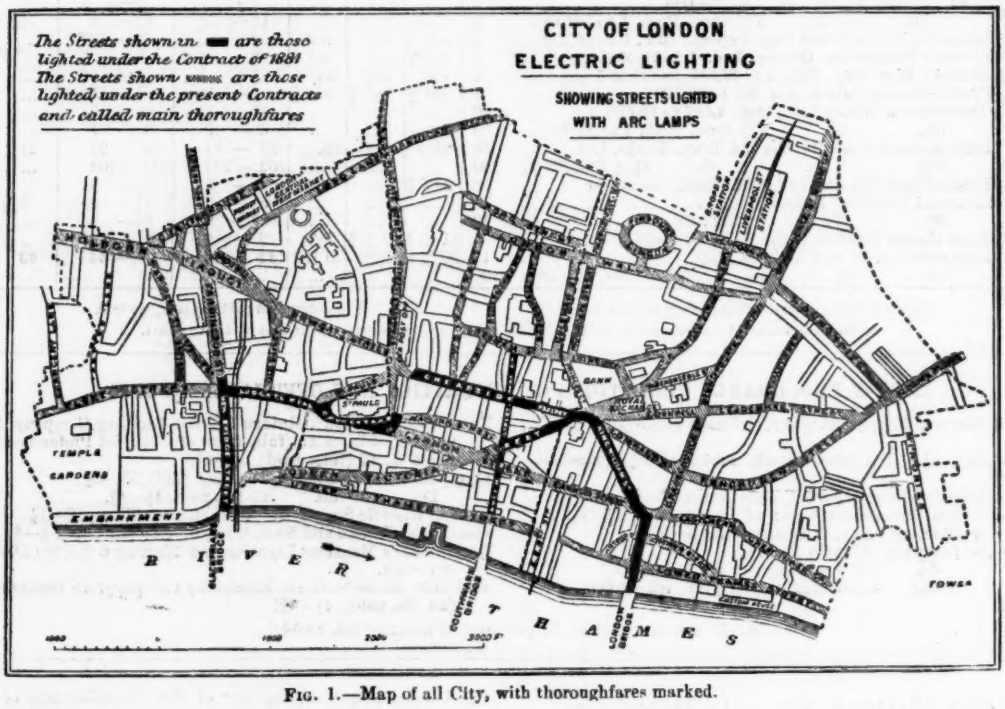

The Streets shown in ■ are those lighted under the Contract of 1881
The Streets shown ▒▒▒ are those lighted under the present Contracts and called main thoroughfares
CITY OF LONDON
ELECTRIC LIGHTING
SHOWING STREETS LIGHTED WITH ARC LAMPS
TEMPLE GARDENS
EMBANKMENT
BANK
ROYAL EXCHANGE
ST PAUL'S
CHARING CROSS
SOUTHWARK BRIDGE
LONDON BRIDGE
TOWER
R I V E R
T H A M E S

FIG. 1.—Map of all City, with thoroughfares marked.

The thoroughfares in which the trials were to be made were divided into three districts, and out of six competitors who tendered in October, 1880, the following were selected, and the year's work lasted from April 1st, 1881, to April 1st, 1882:—The Blackfriars Bridge district to the Brush Company; the Southwark Bridge district to the Electric Light Power Generator Company (Lontin system); the London Bridge district to Messrs. Siemens.

Colonel Haywood reported in June, 1882, that, allowing 50 per cent. of loss through the use of globes in the several districts, the increased light afforded, and the cost of the same under the tenders, in proportion to that of gas, were—

	Increased light.	Relative cost.
No. 1 (Brush) ...	... 15	About the same.
No. 2 (Lontin) ...	... 14	Twice.
No. 3 (Siemens)	... 13½	3¾.

Thus the City of London had taken the lead in making a practical experiment on a large scale.†

The encouragement afforded by the results may be estimated by the following:—

(*a*) The commissioners decided to experiment again in four additional areas, and, calling for tenders, received in May, 1882, offers from eight firms. In one tender only was the question raised of supplying light for private consumption.

(*b*) Messrs. Siemens's offer to continue lighting No. 3 district at £3,600 a year, being an advance of £1,330 on their original contract, was declined, and that firm retired from the City.

(*c*) An arrangement with the Brush Company to continue for another year lighting No. 3 district at a cost of £800 per annum was made.

But, as we all know, the Electric Lighting Act of 1882, which obtained the Royal consent, and became law in that year, appeared, and with it a flood of applications for provisional orders and licenses, three of which covered the area of the City, and obliged the commissioners to hold their hands and consider the position in which the Act placed them, after having already had the subject in hand for nearly four years.

In November, 1882, the Streets Committee of the Commissioners of Sewers consulted Mr. Preece, and I shall take this opportunity to remind him of a statement he then made, and has since repeated, on the subject, in which, I am happy to be able to say, he showed an accuracy of foresight in which later experience has fully supported him.

At that date he wrote: "I know of no branch of engineering where more forethought is necessary to calculate all the contingencies likely to be met with than a system designed to illuminate a large city like that of London."

Meantime an experiment with public lighting by glow lamps had been in progress. In April, 1882, the Edison Company commenced an experiment with that means of illumination on the Holborn Viaduct for a length of 466 yards, upon which Colonel Haywood reported after a twelvemonth's run. Ninety-two 16-C.P. glow lamps replaced the gas burners in the existing street lanterns, 86 14-C.P. gas batswing burners being displaced. The result in light and cost was that the electric lighting contractors gave 1¼ times the light at the same price as gas—namely, £4 10s. 4d. per burner per annum.

That this experiment led to but negative results we all know. If it showed anything, it was that the substitution of a glow lamp in the ordinary street lantern for the lambent flame of a gas jet, so that the incandescent filament is directly visible, is a very poor and unintelligent application of the electric light, and puts it in a position in which it is at a great disadvantage in comparison with gas. I believe that the glow lamp for public lighting purposes never quite recovered from the results of that experiment.

The City was one of the earliest areas upon which the electric light manufacturing companies set their eyes. Hardly had the 1882 Act become law when, as I have said, three companies commenced applications for provisional orders. As still now occurs, the local authority took alarm, and began to investigate the subject for themselves. Most complete reports as to the law, engineering, and science of the question were made by Mr. Baylis, Colonel Haywood, and Mr. Preece. These gentlemen may be said to have been amongst the very first to compile information for a local authority on the subject of electric lighting; and, although ten years have passed, the terms they used, conclusions arrived at, and recommendations made, differ very little from those that have since, and up to this date been, and are being, laid before similar governing bodies for their information and guidance.

The general tenour of the recommendations made in 1883, especially by Mr. Preece, were that the commissioners ought to obtain their own provisional order or license, and, either by contractors or by their own officers, to carry out the undertaking for themselves, both for public or private supply.

The consequence was that in March, 1883, the commissioners decided to apply to the Board of Trade for the necessary license under the Act of 1882, for the whole City, having in its terms a compulsory area of a limited size, and to oppose all other applications for provisional orders and licenses under the Act of 1882.

Although tenders from a number of electric light manufacturing companies were called for and received, it is of moment to note that Mr. Preece reported that their terms were all "eminently unsatisfactory."

No doubt his criticisms were correct, but, as the length of time of the proposed contract was limited to seven years, it is not surprising

* At the same time the Metropolitan Board of Works had been making experiments with the same company's plant on the Victoria Embankment, including photometric comparison of the gas and electric light.

† It was estimated to cost over £8,000, but through the inability of the contractors in No. 2 to commence lighting in time, and for other reasons, it actually cost about £5,400.

that they were not such as could be accepted. The lowest and highest offers for each public light arc lamp were £36 and £71 per annum, respectively.

In spite of amendments in those proposals, Mr. Preece could still find nothing to recommend them; but we, who look back to what has transpired in the interval, can realise that all proposals made in those days, when the security offered was such that capital recoiled from it, were necessarily wild and unsatisfactory, and were mostly made by firms who, if they were sound, must have secretly hoped never to be called on to carry them out.

Meantime, the Anglo-American Brush contract for lighting, for about 4,030 hours per annum, New Bridge Street, Ludgate Hill, and St. Paul's Churchyard still ran on, and was costing the City at a rate of less than £25 a lamp.

Then, in 1883, commenced a period during which companies proposing to obtain statutory powers within the City were kept at arm's length, and during which, Mr. Preece, instructed by the commissioners, made experiments on the subject of public lighting by arc and glow lamps, partly with the aid of the Anglo-American Brush and Edison contract installations then running.

In 1883 he reported "that, while the arc lamp is admirably adapted for the illumination of large spaces, the glow lamp is eminently adapted for our streets and narrow thoroughfares."

Mr. Preece's report to the Commissioners of Sewers, of August, 1884, while being very exhaustive as to the whole question of electricity supply generally, is certainly also the standard report on the subject of public lighting.

He then stated, however, that "the lamp which, in my judgment, best lends itself to street lighting is the glow lamp, and of the glow lamps I prefer the 50-candle lamp for the main thoroughfare."

Notwithstanding the Holborn experiments, Mr. Preece recommended further trials of public lighting with glow lamps, combined with a means of distribution for private lighting within a small area that would require about 5,000 private lamps, at a cost to the City of about £40,000. He also brought very prominently to notice the very valuable proposals of Mr. Trotter connected with his dioptric lantern, to which I shall myself allude later on.

These further experiments were never carried out, but I think the meeting will be glad to hear from Mr. Preece if any modifications would now be admitted into his views, on a subject which the meeting is aware is not yet satisfactorily settled?

For more than a year the subject slept.* At that time it fell to my lot to be placed in engineering management of the Anglo-American Brush Electric Light Corporation, and since then, up to July, 1892, I was intimately acquainted with all that has gone on connected with the lighting of the City of London.†

The original contract of 1881 of that company for lighting New Bridge Street, Ludgate Hill, and St. Paul's Churchyard, with arc lamps, still ran; but there were many outward signs of considerable repairs being necessary in the mains.

These mains had been laid into the district under the roadways from the Brush Works in Belvedere Road, along Bankside, and over Blackfriars Bridge, and they consisted of two circuits of 7-16's drawn into the same cast-iron pipes, with insufficient draw-boxes and means of inspection; although the insulation was sound throughout the greater portion of their length, there were many points at which it had been attacked, by the pipes having been hastily laid where they were exposed to soil saturated by sewage liquids and other gases, and with insufficient means of access for localisation and removal of faults.

The currents were generated by Brush arc dynamos, old-pattern armatures, having belt gearing, to engines, which, with the boilers, formed part of the power which was used in the Brush factory, on which the demands were irregular and occasionally very heavy. The fact was that the Brush Company, when they tendered for the work in 1881, understood it was to be an experiment, out of which little or no actual profit could be expected, and little thought that arrangements which would have been good enough for 12 months would be continued by the City authorities for five years, only terminating through the initiative of the Brush Company, and by the permission of the commissioners, in December, 1885.

No public body has probably taken more pains than the commissioners to weigh carefully the *pros* and *cons* bearing on the question of their becoming themselves the undertakers for supplying electricity;‡ and I think now that, but for the host of offers, merely speculative and otherwise, which was being continually sent in to them and diverting their attention from the issues most in the interests of the ratepayers, they would in the end have decided on raising the necessary capital to do the work themselves.

In November, 1885, a set of proposals was formally made by the Brush Company to contract for the public and private supply of a district of the City, and this was considered by a committee, of which Mr. J. C. Bell was chairman.

This was the first practical arrangement on a large scale that had ever come before the commissioners, and its terms are almost *verbatim* those that were eventually adopted in January, 1889, as the conditions under which the commissioners would receive tenders.

From that moment the question of lighting the City made a fresh start on a tangible basis as to cost and mutual advantages; and, although it took five years to mature, there was no longer any serious question of the commissioners themselves becoming the undertakers. In 1886, 1887, and 1888, the matter was again from time to time before them, and throughout that time it was due to the personal exertions of some enlightened members of the Streets Committee that the matter was kept continually to the front.*

One of the reasons for the delay was due to a great reluctance on the part of the commissioners to permit any company to have a provisional order within its area of control.

The chief reason for this was the condition of things at and below the surface. The occupation of the subsoil by sewers and subways, by the systems of gas, water, and telegraphs, and by various other objects, is entirely exceptional. They would have much preferred that all powers for the disturbance of the surface should be conferred by themselves only, and not by statute.

There is no doubt that the ratepayers of the City would now be in quite as good a position if no provisional orders had been granted, and if only the contracts that were eventually entered into between the commissioners on the one part, and the Brush Company and Messrs. Laing, Wharton & Down on the other, were existent. Owing to more than the ordinary rights of user of the soil of thoroughfares and streets being vested in the City Corporation, statutory powers were not necessary to enable them to grant way-leave.†

In February, 1888, the commissioners called for a report giving a *resumé* of all that had been brought before them in the previous ten years, and I must here say that it fully establishes the claim of the Brush Company that a large share of the credit for the eventual results was due to their persistence in holding the ground when all others had retired, and in keeping the subject always before the local authority in a manner and in terms which, by their moderation and practical sense, were bound in the long run to commend themselves to business people.

The object of this report was to show that the successful use of arc lamps for illuminating large spaces had asserted itself all over the civilised world.‡

The advantage of having a contract with a company to supply current to public arc lamps at 3·1d. per unit, including trimming and carbons, instead of at 8d. exclusive of the same—the usual price in provisional orders—was dwelt on.

The unsatisfactory nature of the proposals made to the City by other parties was fully exposed. The great advantage to the City if the terms of the form of contract originally proposed by the Brush Company in 1885 were adopted, and the misrepresentations which suggested monopoly that had been made, were dispelled; and, it is a remarkable fact, that the then proposed charge of 1s. per unit for private lighting was not considered excessive in view of the circumstances of the probable demand for business premises in the City.

January, 1889, found the commissioners, again and finally, roused to activity by the Electric Lighting Act of 1888 (due to the personal exertion of Lord Thurlow, the chairman of the Brush Company), and, the City having been divided into three districts for the purpose of the contracts, tenders were publicly called for; and it may here be remarked that the Company which, during eight years, had done so much to keep the matter before the public, at that moment was in no better position in March, 1889, as regards tendering, than any other firm which was then only dealing with the matter for the first time.§

But yet another stage of opposition had to be got over before the final arrangements for this great undertaking could be said to be on a satisfactory footing.

Major Marindin, in April, 1889, had reported against the claim of the City to be exempted from the operation of the Electric Lighting Act, and had, in face of the opposition of the City, recommended the approval by the Board of Trade of the applications for provisional orders from two of the above-named companies.

The Brush Company had for several years, in deference to the views held by the City authorities, refrained from making applications for orders, and therefore their absence from the list of applicants in 1889 was intelligible.

In the terms of Mr. Preece's report on Major Marindin's contention, the City had been "regarded merely as a local Vestry with some ancient rights that have to be respected;" and that "the amount of lighting and the capital necessary to be expended in the City, which far exceeds that for any other portion of the Metropolis," had been overlooked. Major Marindin by his recommendation had neglected not only the geographical part of the question, but the fact that the Commissioners of Sewers had been for years studying and experimenting on the question of effective public street lighting.

The tenders for public lighting the main thoroughfares (see plan No. 1) with arc lamps which eventually were reported on, in November, 1889, by Mr. Preece and Colonel Haywood, were:—

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* In November, 1885, a well-known writer reported to the commissioners:—"At the present time there is a complete stagnation in electrical enterprise in England, in such enterprise as would undertake the supply of electricity upon a large scale for public and private purposes in towns."

† My own connection with the public lighting of the City of London dates back to the sixties, when I assisted the late Dr. Letheby, City Analyst, in a series of experiments connected with carburetting gas for street lamps.

‡ So late as April, 1890, they deputed Mr. Preece to report to them on the electric lighting of the public streets of Taunton with arc and glow lamps.

* Mr. Frank Green, Mr. J. C. Bell, Mr. Graham King, Mr. Bridgeman, Mr. Pannell, and others.

† There is ample experience to show that, if much of the Act of 1882 had been repealed, so far as the metropolis was concerned, as was more than once urged on the Board of Trade, this, and many geographical and other anomalies, which have kept up, and will for many years keep up, the price of electricity in London, might have been avoided.

‡ The successful lighting on a large scale by the Brush Company of the Colonial, Manchester, and Glasgow Exhibitions was described.

§ The contractors who tendered were the—

1. Central—Anglo-American Brush Corporation.
2. London—London Electric Supply Corporation.
3. West—Metropolitan Electric Supply Company.
4. All—House-to-House Electric Supply Company.
5. East—Messrs. Laing, Wharton & Down.

The Metropolitan Electric Supply Company's revised tender to light the western district with 121 lamps, at £26	£3,146
The Anglo-American Brush, the central district with 138 lamps, at £26	3,588
The London Electric Supply Corporation, with 136 lamps (half the lamps being extinguished at midnight), at £24 2s.	3,290
Total for the main thoroughfares	£10,024

and the acceptance of these was recommended.

But of them the Brush Company alone (consistent with their original proposal) had not applied in 1889 for a provisional order, and had agreed to the division of profits under a sliding scale—namely, that if the profits exceeded a cumulative dividend of 10 per cent. per annum upon the capital invested, the excess was to be divided equally between the contractor and the consumer—and also had agreed that power should be reserved to the commissioners to acquire the undertaking and works by purchase at the end of 21 years, in all other respects in accordance with section 2 of the Electric Lighting Act of 1888.

Meantime no provisional orders had been granted for any part of the City area, owing to the withholding of the usual recommendations from the local authority which the Act requires.

But on the last day of June of that year the Brush, and the Laing, Wharton & Down companies gave notices for the western and central, and the eastern districts respectively, and the ordinary statutory steps followed in due course. The Brush Company had, as stated, accepted the terms of the commissioners' contract, and the Laing, Wharton & Down Company now decided to fall into line with them;* and in May, 1890, those contracts were sealed, and the provisional orders became law in that session of Parliament.†

Not until 1891 were a similar contract and provisional order granted to the Brush Company for the western district. Thus, after nearly 13 years of deliberation on the subject, the scheme for supplying electricity to the City of London for public and private consumption became legally possible, and all the special powers which the commissioners sought to obtain in the interests of their ratepayers had been secured.

Capital Expenditure.

The question of raising capital for electricity supply companies has not differed much in its conditions from other sister industries.

This paper would be less instructive if that part of the subject was overlooked, and it is noteworthy that, even with a field for the supply of electricity in which the gas company had a gross income of over £370,000.‡ Even in 1891 it was not thought prudent to do what is called "go to the public," in the first instance, with a plainly stated prospectus. Such a statement most certainly would have shown that the supply of electricity to the City should be an undertaking affording as sound an investment as could be found anywhere, and also one which, at an early date, under the operation of the sliding scale already alluded to, would allow of the cost of the current being reduced below the maximum of 8d.

As we all know, a very old way of commencing to raise capital has been brought out under a new name, namely, by the starting of a "pioneer company," which is one way of getting an instalment of capital together to make a beginning.

Of course there is no engineering justification for it, but the financial physician has prescribed it, and hence this first capital must be spent with a primary object of showing that something can and will be done.

The future of the undertaking from the structural point of view may become quite a secondary consideration, and, indeed, may be ignored if it interferes with the parade with which it is intended to "draw" the investing public. They—the public—have only themselves to thank if this sort of thing is necessary. Engineers and contractors have no real interest in its existence.

The contracts with the commissioners for the public lighting of the City were dated—

For the Eastern district, May 28th, 1890;
" Central " " 19th, "
" Western " February 5th, 1891;

and they required that the main thoroughfares should be completed with arc lamps in the Eastern and Central districts by February 28th and 19th, 1892, respectively, and in the Western district by November 5th 1893.

The "first sod was cut" on January 5th, 1891, when a junction box was constructed on the west side of the Mansion House, with an inscription inserted in the wall. The first street was lighted in July, 1891.

The arc lighting generating plant was permanently fixed in the pioneer buildings, but in other respects the installations were designed to be temporary.

The two companies—namely, the Brush Electrical Engineering Company, and the Laing, Wharton and Down Construction Syndicate—to whom, as has been stated, the provisional orders and contracts had been granted, had in February, 1891, transferred their interests, through an exploration company and an electric and general investment company, conditionally, to the City of London Pioneer Company, of which company I was appointed the engineer after the contracts had been made. These interests included the obligation to complete the purchase of sites for generating stations—one at the Wool Quay, in Lower Thames Street, the other at Meredith's Wharf, in Bankside.

Part of the consideration for the transfer of the responsibilities and liabilities of the "*concessionaire*" companies was in each case a provisional contract for the supply and erection of the entire plant and equipment of one temporary (or pioneer) and one permanent generating station for the supply of current to, and for the transforming of current in, each district.

In similar cases the work of pioneer companies has been confined to the task of financing. Unfortunately—I think—in this case the City of London Pioneer Company had to undertake actual work, so far as the public lighting was concerned, because the time remaining—namely, about 12 months—in February, 1891, when the contracts for the Central and Eastern districts had to be completed, was even then very short.

But these provisional contracts for temporary work included some private lighting;* the object being the old-fashioned one, to create a display—in my opinion—at the expense of good work, and with the risk of a legacy of trouble, anxiety, and failure.

Suffice it to say that, in spite of every possible precaution to prevent it, no small part of this temporary work has had, or will have, to be moved or altered after having been put to work; and a large part of the money spent on these temporary installations—amounting, together with other expenses, to a very considerable sum—must be more or less wasted.†

On July 13th, 1891, while the pioneer contracts were still uncompleted, all the interests acquired by the pioneer company were taken over by the City of London Electric Light Company for a further consideration, by which means the lighting of the City was, with the consent of the Board of Trade and of the City authorities, amalgamated into one undertaking instead of three, and it was at last possible to begin work in earnest, with a hope that the words "temporary" and "provisional" were past.

The estimates for works upon which the capital of the new company was raised, amounted to:—

Buildings	£53,000
Equipment of the three stations	493,250
Distribution	342,850
Total	£889,100

This was exclusive of the cost of the sites.

The contracts for public lighting with the "*concessionaire*" companies which had been taken over from the pioneer company, besides providing for the supply and installation of the plant and equipment for one station for each district of the City, provided also the arc and glow lamps for the public lighting, with their fittings, exclusive of posts and lanterns, in every respect sufficient to enable the new City company to fulfil the terms of the contracts with the Commissioners of Sewers, as follows:—

Eastern district. (Laing, Wharton and Down Company.)		Central district. (Brush Electrical Engineering Company.)		Western district. (Brush Electrical Engineering Company.)	
Arc.	Glow.	Arc.	Glow.	Arc.	Glow.
233	307	138	302	144	297

Total arc, 515. Total glow, 906.

Besides this, the contracts between the same parties required the work to be done for equipping the stations and providing the plant for the supply and conversion of current for private lighting to be in accordance with detailed specifications and schedules of prices. It was agreed that these details and prices were to be laid down afterwards, and settled between the engineer of the company and the contractors; differences (if any) to be referred to Mr. Preece.

* The commissioners had required Mr. Preece to report fully on the Thomson-Houston system of arc lighting as established at Sheffield and the St. Pancras Station, as well as at Taunton.

† The names of Mr. E. Garcke and of Mr. Sydney Morse are so well known in connection with the industry, that it is appropriate to record here that to them is largely due the credit for carrying through final arrangements for these orders, which were exceptionally intricate in their character.

‡ The day and night populations of the City, respectively 261,061 and 50,652 in 1881, had altered in 1891 to 301,384 and 37,694. The day population, as compared with counties and towns in England and Wales, is larger than 26 counties, and all other towns except Liverpool, Manchester, Birmingham, Leeds, and Sheffield. Before 1891 there were 3,136 public gas lamps, costing £10,530 per annum.

* The first current for private lighting was commenced on December 11th, 1891, to the Mansion House, but it was more than six months after before the plant could be run during daylight hours.

† I had been through such troubles in connection with electrical and other engineering too often not to throw all my weight into the scale against temporary work of any kind.

It is only before an assembly of engineers that an engineer can hope to find any appreciation of such a situation. Neither financiers nor contractors sympathise with his efforts to prevent unnecessary expenditure, except so far as it affects their own interests. The financier does not mind so long as the total expenditure is within his estimates of what the investor will stand; and the contractor need only care if he is going to accept any payment in shares, and not always then.

Besides this, there is the long series of harassing engineering consequences arising out of crude, hasty, and ill-considered work preliminary to a great undertaking. Many of us have been through it, and learnt to take it as part of the day's work; but, all the same, it is always regrettable.

The contracts required that the output of the Brush stations for the supply of the central and western districts, and of the Laing, Wharton & Down Company's station for the eastern district, should, including the pioneer plant, be as follows:—

	Public and other arc lighting. Kilowatts.	Private lighting. Kilowatts.
Eastern district	450 ...	4,800
Central „	330 ...	3,900
Western „	220 ...	3,400
	1,000 ...	12,100
		1,000
Total kilowatts		13,100

Adding together the cost of the contracts and estimates, and dividing by the total of 13,100, we obtain the following total cost per kilowatt:—

Preliminary expenses...	£8,000
Work done by the pioneer company, including some work of distribution	46,000
Extras on ditto	10,000
Contracts for the stations	493,250
Estimate of cost of completing distribution ...	342,850
	900,100
Add 8 per cent. for the cost of the sites of the generating stations	72,008
Total	£972,108

Namely, total per kilowatt, nearly £75.

Anyone present will realise that the preparation of detailed specifications for the equipment of an electric light supply station, both for generating and transforming, requires the fullest technical description. Besides that of the boilers, engines,* and dynamos, there are the questions of the arrangements for transport and conveyance of coal and refuse, economising, condensing, and stoking; there are also the details of foundations, drains, subways, travellers, lifts, cranes, and the lighting of the station, as well as telephonic communication with, and equipment of, transforming sub-stations.

I need not say that the preparation and agreement as to the details of specifications, after a contract is made and the total price to be paid is fixed, is a somewhat novel task for the engineer of the spending company.

In this case the putting of the cart (as it were) before the horse fortunately did not end in miscarriage. The engineers on both sides† were anxious, while doing justice to their employers, to arrive at a fair and reasonable solution, and Mr. Preece could tell you that it ended in only about half a dozen points of difference between them and me having to be referred to him in specifications containing nearly 120 pages of closely-printed matter.

In these specifications, although the specialities of the two contracting firms were well known, nothing was laid down to confine them to their own particular make of engines, boilers, dynamos, transformers, and lamps.

The contractors described to me the sizes of the units they desired to employ. They are not limited to any particular form of driving, and, as far as possible, to produce uniformity, the speeds and electrical conditions which they desire to use are allowed.

Economising, automatic stoking, and condensing, and all possible accessories—including testing and switch-room apparatus and fittings—are required of capacity equal to the full output of the plant.

All the conditions of the different stages of generating are rigorously prescribed so far as the results under test are concerned. For instance, it is laid down in the specifications that, after providing for all extraneous steam consumption and waste, the standard of consumption of coal, including the steam used in the condensing pumps, shall not exceed 5 lbs. for the high-tension alternating currents, and 7 lbs. for the high-tension continuous currents, per Board of Trade unit delivered at the terminals of the primary mains in the stations. Amongst the extraneous uses of steam to be excluded from the above basis are included that used for the power expended in moving water, coal, and refuse.

The tests to prove this are adapted to the circumstances of running the station ‡—a matter, as most of us know, not always easy. Therefore their nature and number are to be subject to the approval of the engineer, so as not to clash with the conditions of statutory supply from the station.

The tests of each unit estimated to have an output of 400 kilowatts, or of each group of units with an output of 1,200 kilowatts, are necessarily dependent on the circumstances of the load on the station.

The alternating plant—both Brush and Thomson-Houston—was experimental at the time the contracts were made, therefore the first examples had to be under trial for six months. These trials had to be coincident with the supply, and dependent on the load at the station, and the contractors for that period were to be responsible for failure of all kinds.

Under strict penalties, the contractors are answerable for the dimensions of foundations, flues and chimneys, and are required to guarantee absence of vibration, noise, and smoke nuisance.

As regards the boiler tests, under the usual conditions of temperature, external and at the base of the chimney, and state of barometer, and with coal having a calorific value of 13,500, it is obligatory that 77 per cent. of the heat is transferred to the water by the boilers and economisers together.

As regards the consumption per H.P. of steam in the engines, the Brush Company have agreed to a limit with full load of 22 lbs. of steam exhausting to the atmosphere, and 18 lbs. when condensing. The Laing, Wharton & Down Company have agreed to a limit of 20 and 17 respectively.

For the commercial efficiency of the electrical 400-kilowatt generators, 80 per cent. when working at full load is prescribed, 2 per cent. of that only being allowed to be absorbed in the excitation.

Besides, there was given a description of every test which each portion of the plant would be required to sustain. At the same time the widest latitude as regards *design*, throughout the whole of the station plant and accessories, is allowed.*

I do not know if the meeting considers if any better way could be adopted for protecting the expenditure of capital and stimulating the energies of contractors, after it had been decided by others how much should be spent, how much should be the maximum output of the plant, and who were to be the contractors.

What was probably one of the most difficult parts of the task was the description of the details of the adaptation of portions of the plant to sites and buildings still under design, so that no extras on the contracts should arise, and thus the equipment of the stations and sub-stations should be of the most complete and up-to-date description, and fully equal to the requirement of the capacity which the contractors had undertaken to provide.

Both sites presented exceptional features, and the designing of the building structures for each differed entirely.

That for the Wool Quay (since abandoned)† required a building in which the floor of the basement would have been 20 feet below high-water mark, and the station plant should be placed on floors one above the other; the generators to be in the basement, the boilers over (on a Hobson's steel girder floor), and the coal above.

The site at Meredith's Wharf, although the essential features of the first design have been retained, has been so enlarged, that any description of it that might be attempted in this paper would not be sufficient.‡

The estimate of the load-factors of the *public* lighting of the City may be here made with some interest.

Adopting Mr. Crompton's figure, which allows 25 per cent. for extra or reserve machinery, in the case of the public lighting, the capacity of the plant is 890 − 222 = 668 kilowatts, or 5,851,680 kilowatts per annum. The 515 arc lamps represent 257,500 watt-hours, and the 906 glow lamps—half being 100 watts, and half 50—represent 67,950 watts more, or a total hourly consumption of 325·45 kilowatt-hours, which, with 4,030 running hours in the year, gives a load of 1,311,562 units per annum.

But, in fact, the amount of the above plant that is spare, or available for arc lighting in public buildings and elsewhere, is very large, and it is better to regard the actual capacity of the plant exclusively devoted to public lighting, including reserve, as represented by 16 50 (500-watt) light machines, with an annual total capacity of 3,504,000 kilowatts. This will give a load-factor of 37·4.

(*To be continued.*)

NEW PATENTS—1894.

1,886. "Improvements in switches and automatic movements for use in connection with telephones." H. Marrian. Dated January 29th.

1,903. "Improvements in or relating to electrodes." M. Wuillot. Dated January 29th.

* Prof. S. P. Thompson's opinion, in November, 1891, on the types of engines which the contractors, under the restrictions and definitions contained in the specification proposed to adopt, was that, while expressing his own opinion on the advantages of triple expansion, and of engines of the closed type, he confirmed entirely the conditions that the choice should be of the vertical and direct-coupled type; he postponed his final opinion until six months' running of the first group of 400 kilowatt units had been completed. It is to be hoped that he will be able now, more than two years having passed, to give electrical engineers his further experience in the subject.

† Mr. Raworth and Prof. Kennedy, assisted by Mr. Wharton, represented the two contracting parties, while I represented the City of London Electric Lighting Company.

‡ The contractors could not provide means of running their large dynamos at their works. All real tests had to be made after delivery. This was an inherent difficulty for the engineer.

* The essence of these specifications was that, except in respect to a few points not within the scope of the contractors' work as electrical engineers, all details of design were left to them, subject to the final approval of the engineer.

† This site had to be taken over by the City company under the "*concessionaire*" contracts.

‡ The Institution will be better served if I leave it to the gentlemen who were selected by me as my assistants for that part of the work, and who have actually since carried it out—namely, Colonel Seddon (late R.E.) and Mr. C. Thompson. The meeting will, I hope, understand that in refraining to give any detailed description of the equipment of the stations, I am influenced by the wish that such should be undertaken either by the engineers of the respective contractors who designed and erected them, or by Mr. J. H. Jackson (one of my assistants), who is still superintending the same. As regards the building structures, I may, however, add that of three chimneys designed, and specified and contracted for under me, one—*i.e.*, that now to be seen close to Bankside—has been erected. There are features of its construction, especially with reference to the bond, that I should like to have time to describe. Its cost was £2,075, its height 150 feet, and its internal diameter 12 feet.

1,919. "Improvements in telegraph relays." C. Langdon-Davies. Dated January 29th.

2,007. "An electric switch." The Edison and Swan United Electric Light Company, Limited, and C. F. Proctor. Dated January 30th. (*Complete.*)

2,048. "Improvements in dynamometers." R. Voigtlander. Dated January 30th. (*Complete.*)

2,065. "Improvements in gas and oil engines." J. P. Binns and H. G. Binns. Dated January 31st.

2,098. "Improvements in the manufacture of insulated wire." H. H. Brown. Dated January 31st.

2,104. "Improvements in electric switches to be used in conjunction with contacts for continuous ringing." G. J. Gurl. Dated January 31st.

2,105. "Improvements in arc lamps." F. Brown and C. H. Offord. Dated January 31st.

2,111. "Improvements in or relating to fuel economisers." A. Roberts and H. Roberts. Dated January 31st.

2,112. "Improvements in electric lamp holder switches and the like." T. H. Caley. Dated January 31st.

2,118. "Electric light improvements. V. Fabris. Dated January 31st.

2,203. "An improvement in electric candle lamps." G. Durlacher, A. Lacoste, and W. Lowry. Dated February 1st. (*Complete.*)

2,211. "Improvements in microphones." Sir C. S. Forbes, Bart., and The Domestic Telephone Company, Limited. Dated February 1st.

2,217. "Improvements in dynamo-electric machines." H. Chitty. Dated February 1st.

2,250. "Improvements in galvanic batteries. O. Hund. (Communicated by G. Wehr, Germany.) Dated February 1st.

2,251. "Improvements in galvanic dry batteries." O. Hund. (Communicated by G. Wehr, Germany.) Dated February 1st

2,262. "Improvements relating to electroliers and ceiling roses for same." A. Ashby. Dated February 2nd.

2,274. "Improvements in the means for electrically propelling tramcars and other vehicles and the apparatus therefor." P. J. Pringle. Dated February 2nd.

2,321. "Improvements in or connected with dynamos." W. E. Yates and A. Clegg. Dated February 2nd.

2,332. "A method of hauling by electricity, and apparatus for that purpose." F. B. Behr. Dated February 2nd.

2,366. "System of underground electric traction." J. E. Palmer. Dated February 3rd.

2,424. "An electric locking device for door locks." D. de Mito. Dated February 3rd.

2,437. "Improvements in and relating to electric time alarm and synchronising apparatus." A. A. C. e Bastos. Dated February 3rd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

4,489. "Improvements in and relating to electric fire alarms." E. C. C. Krogh. Dated March 1st. Relates to fire alarms of the class employing an electric circuit to actuate the alarm, which circuit is normally open, but is closed by the action of a thermostat actuated by a rise in temperature in the surrounding atmosphere, due to the presence of a fire. 5 claims.

4,818. "Improvements in the construction of electric light switches and cut-outs." C. M. Dorman and R. A. Smith. Dated March 6th. Consists principally of an improved form of the terminal pillar described in patent No. 16,434, September 14th, 1892. 4 claims.

5,709. "Improvements in the cores of armatures and inductors for dynamos, magneto-machines, motors, and other purposes." H. F. Joel. Dated March 16th. Consists in making the cores of armatures for continuous or alternating current dynamo machines, magneto-electric machines, motors, and other purposes of shaped coils of soft iron wire, or of thin iron ribbon or tape. 4 claims.

6,031. "An improved system for transmitting electric currents." B. J. B. Mills. (A communication from W. Courtenay, of New York.) Dated March 21st. The currents in this system remain separate, though connected by a common return, as they will not pass through the intervening matter between the lines, owing to the greater resistance offered than by the wire. 3 claims.

6,073. "Improvements in arc electric lamps." J. E. A. Gwynne and Rankin Kennedy. Dated March 21st. Relates to electric arc lamps, in which the regulation of the movement of the carbon holders is effected directly by the movement of the core or cores of one or more solenoids, without the aid of clockwork clutches or other mechanism, and has for its objects, firstly, to increase the duration of the lighting or burning period, relatively to the lengths of the solenoids and cores of an arc electric lamp, and secondly to adapt such lamps to work effectively with alternating currents as well as with continuous currents. 4 claims.

6,295. "Improvements in and relating to electric incandescent lamps." T. Stober. Dated March 24th. Consists in forming the base of the lamp with a removable plug, which carries the filament holders, and is furnished with an air cock or valve. 1 claim.

6,468. "Improvements in electric arc lamps." Siemens Bros. and Co. and J. Nebel. Dated March 27th. Has reference to the construction of electric arc lamps, described in the Specification to Patent No. 366 of 1888, in which the upper carbon of the lamp was suspended from a spring barrel, controlled by an escapement and by a pivoted frame, carrying an armature that was acted upon by an electro-magnet in a shunt of the lamp circuit. 2 claims.

6,478. "Improvements in and relating to dynamo-electric machines and motors, and to circuits for use in connection therewith." Elihu Thomson. Dated March 27th. Relates to high potential circuits and to the construction of dynamo-electric machines and motors, and is especially adapted to the construction and protection of alternating current machinery, in which high potentials are to be obtained, and correspondingly high insulation is necessary. 8 claims.

6,559. "Improvements in electric heating apparatus." M. W. Dewey. Dated March 28th. Consists, broadly, in the combination of a thin body of suitable material, notches in one or more of its edges, and a wire forming part of an electric circuit wrapped around said body, across both faces thereof, and lying in said notches. 10 claims.

6,885. "Improvements relating to electric railways." H. H. Lake. (Communicated from abroad by M. A. Cattori, of Rome.) Dated April 1st. Has for its object to set forth all further technical details necessary to constitute a complete installation for underground electrical railways, so as to eliminate every difficulty which may in certain cases be met with when passing the feeding points, that is to say, the points where the current is passed to the line conductor from the generator; in the crossings of track; in the shunts and the like. 6 claims.

7,387. "Improvements in or relating to machines for electrically welding metals." W. P. Thompson. (A communication by C. L. Coffin, of America.) Dated April 11th. Claims:—1. In a machine for electrically heating metal, a support, a yoke movably mounted on said support, a furnace lying in the opening of said yoke, two slides mounted on ends of said yoke, and movable thereon across the path of motion of said yoke, clamps mounted on said slides, and a right and left threaded screw shaft connecting said slides, substantially as shown and described. 2. In a machine for electrically heating metal, a separable furnace consisting of a two-part box, a rock shaft supporting one part of the furnace, and a cam on said rock-shaft for opening and closing said furnace, substantially as shown and described.

7,389. "Improvements in apparatus for electrically welding or working metals." W. P. Thompson. (A communication by C. L. Coffin, of America.) Dated April 11th. Relates to gear for holding and operating upon the parts to be welded. 5 claims.

7,437. "An improved microphone." H. H. Leigh. (Communicated from abroad by C. Mildé Son & Co., of Paris.) Dated April 11th. Claim:—An improved microphone, consisting of a drum or box filled in part with purified grains of coke, and made by the combination of two thin metal sheets corrugated on their faces, through the centre of each of which projects a carbon rod furnished with a weight, one of the rods being fixed to the transmitting diaphragm.

7,702. "Improvements in electric signalling apparatus and systems for railways." J. Y. Johnson. (A communication from abroad by J. W. Lattig and W. F. D. Pascoe, of America.) Dated April 15th. Relates to the employment of an electric motor for actuating the signal operating mechanism, in order to move the signal to safety, the motor circuit being closed at all times, except when a train is on the track section appropriate to the signal. 5 claims.

8,502. "Improvements in electrical railways and tramways." W. L. Wise. (A communication from abroad by A. Diatto, of Turin.) Dated April 27th. Relates to improvements in the construction and operation of the contact boxes; in the manner in which these are arranged; in the means employed for supplying electric current directly from the boxes without opening them; and in the insulation. 4 claims.

8,808. "Improvements in electric accumulators or storage batteries, applicable also as a constant primary element." H. Lehmann. Dated May 2nd. The active mass, according to the invention, consists of commercial peroxide of barium, and as the exciting liquid there is employed a solution of chloride of barium in water. 1 claim.

9,297. "An improved electrolytic apparatus." T. Craney. Dated May 9th. Claims:—1. In an electrolytic apparatus containing an anode in a separate compartment communicating with the cathode compartment through an electrolytic diaphragm, and anode consisting of a body of carbon in a protective casing, and a body of carbon in the bottom portion of the anode compartment and inclosing the lower end of said casing. 2. In an electrolytic cell, a carbon anode comprising a body of carbon contained in an outer protective casing, said casing being provided with perforations in its upper portion in such position as to be above the height of the liquid in the cell.

9,304. "Improvements in electric incandescent lamps." A. J. Boult. (A communication from J. Waring, of America.) Dated May 9th. Claims:—1. The combination of a carbon to be raised to incandescence by electrical excitement an enveloping gas composed wholly or largely of an element or elements of high atomic weight, to wit, as high as that of bromine, a sealed chamber enclosing both the carbon and surrounding gas, and electrical conductors passing through the walls of said chamber, and connecting with the carbon, for the purpose specified. 2. The combination of a carbon to be raised to incandescence by electrical excitement an enveloping gas consisting wholly or largely of bromine, or of iodine or of both, a sealed chamber enclosing both the carbon and surrounding gas, and electrical conductors passing through the walls of said chamber and connecting with the carbon, for the purpose specified.